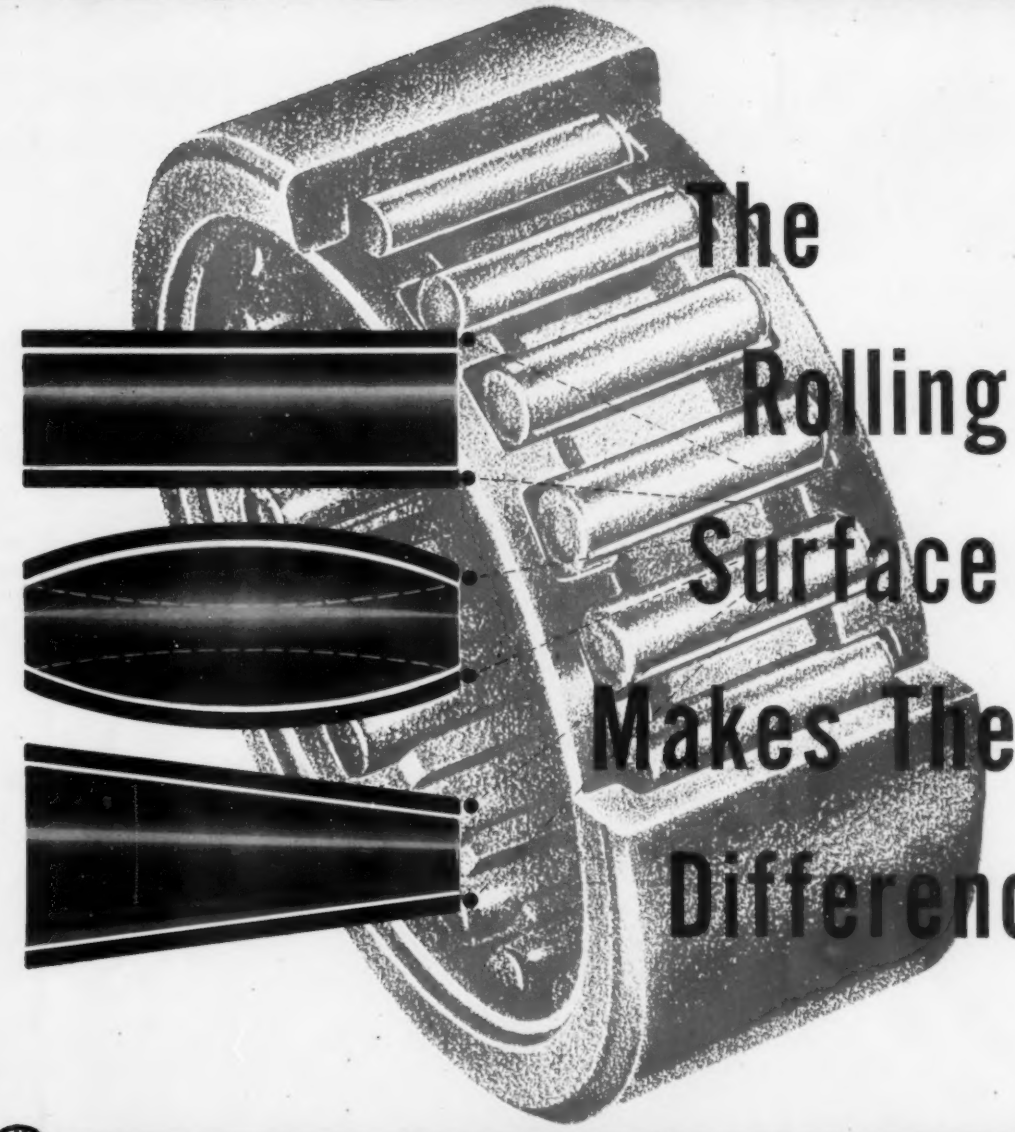
POWER TRANSMISSION DESIGN

SEPTEMBER 1959

OEM··MAINTENANCE



The Rolling Surface Makes The Difference

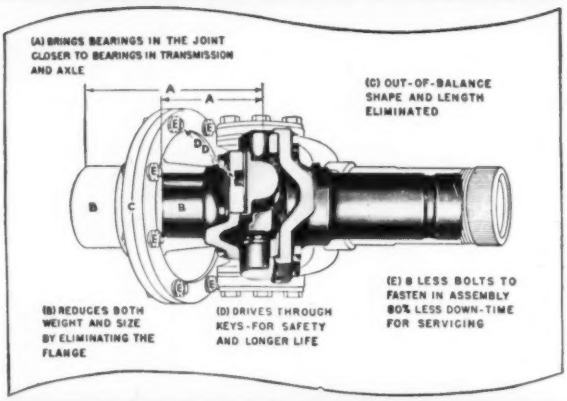
THE MAGAZINE OF MACHINE DRIVES

News and ideas for designers and plant engineers who use power drive equipment

$$\frac{\text{MECHANICS}}{\text{LESS PARTS}} = \frac{\text{LESS}}{\text{ASSEMBLY TIME}} + \frac{\text{LESS}}{\text{WEIGHT}}$$

$$\frac{\text{MECHANICS}}{\text{LESS WEIGHT}} = \frac{\text{MORE}}{\text{PAYLOAD}} \times \frac{\text{HAULS MADE}}{\text{BY TRUCK}}$$

You Are PAYING For MECHANICS JOINTS



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Every time you use a joint that requires unnecessary attachments and extra assembly time and labor, you are paying for MECHANICS Roller Bearing UNIVERSAL JOINTS advantages—but are not getting the benefit of them. And you are forcing your truck to carry unnecessary DEADWEIGHT that should be devoted to PAYLOAD.

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maurey

spring loaded pulleys give you a choice of two variable speed drives

ratios up to 4:1, on 1/8 to 2 h.p. drives

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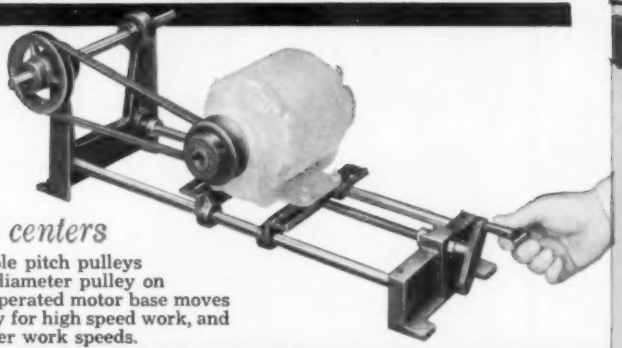
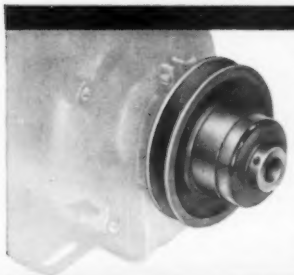


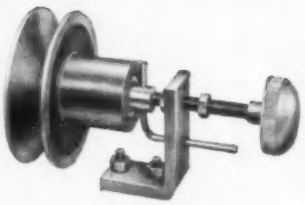
. . . with variable centers

With spring-loaded, variable pitch pulleys on motor shaft, and fixed diameter pulley on driven shaft. Hand wheel operated motor base moves motor close to driven pulley for high speed work, and away from pulley for slower work speeds.



AUTOMATIC
Spring Loaded Pulley. Belt pressure controls pitch diameter. 4 sizes: 3¼", 4", 5" and 6" O.D.

MANUAL
Spring Loaded Pulley. Hand wheel controls pitch diameter. 4 sizes: 3¼", 4", 5" and 6" O.D.

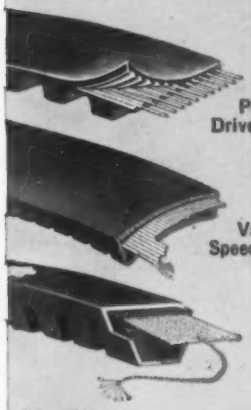


2

. . . with fixed center

Two variable pitch pulleys, one spring loaded and one manually operated, combined for maximum speed variation. Turning the hand wheel on the manual pulley varies its pitch. The slackening or tightening belt produces instant, automatic pitch adjustment of the spring loaded driver pulley for positive driving at the desired speed.

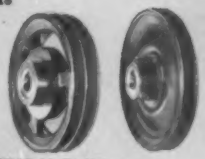
get more **drive** *with Maurey drives*



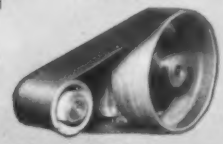
Positive Drive Belts

Variable Speed Belts

Mor-Grip V-Belts



Hi-Q FHP V-Pulleys



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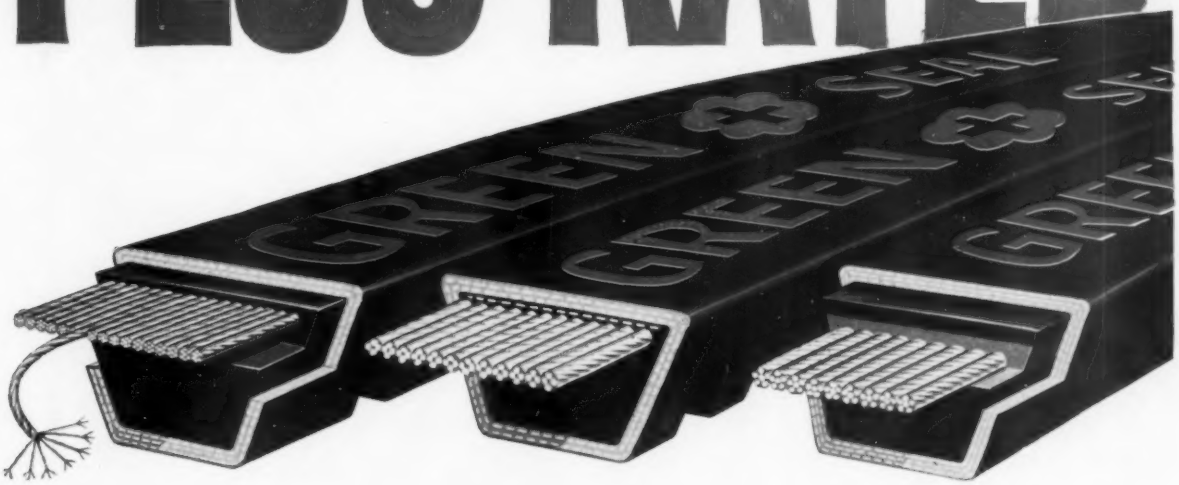
Now they're "PLUS-RATED"



That's right!! All V-Belts with the Green Seal are now "PLUS-RATED."

"PLUS-RATED" means the horsepower carrying capacities of previously standard E-C Cord V-Belts, super-rated Hy-T V-Belts and top-rated Compass-V-Steel Belts have all been substantially increased to give you the maximum in rated horsepower hours per dollar.

Example: E-C Cord V-Belts are now rated at a 40% higher horsepower capacity than ever before.

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2. The "PLUS" ratings have been established only after a careful study of the actual performance of thousands of sets of Green Seal Belts.

The full story on why and how all V-Belts with the Green Seal have been "PLUS-RATED" goes back to their introduction in May 1957, and is too long to detail here. See your Goodyear Dealer for all the performance-proved facts and figures. Or write Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

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Distilled Writing gets magazines read

FEATURES

THE MAGAZINE OF MACHINE DRIVES

September 1959, *volume 1 number 9*

FEATURES

IDEAS FOR DESIGNERS AND PLANT ENGINEERS

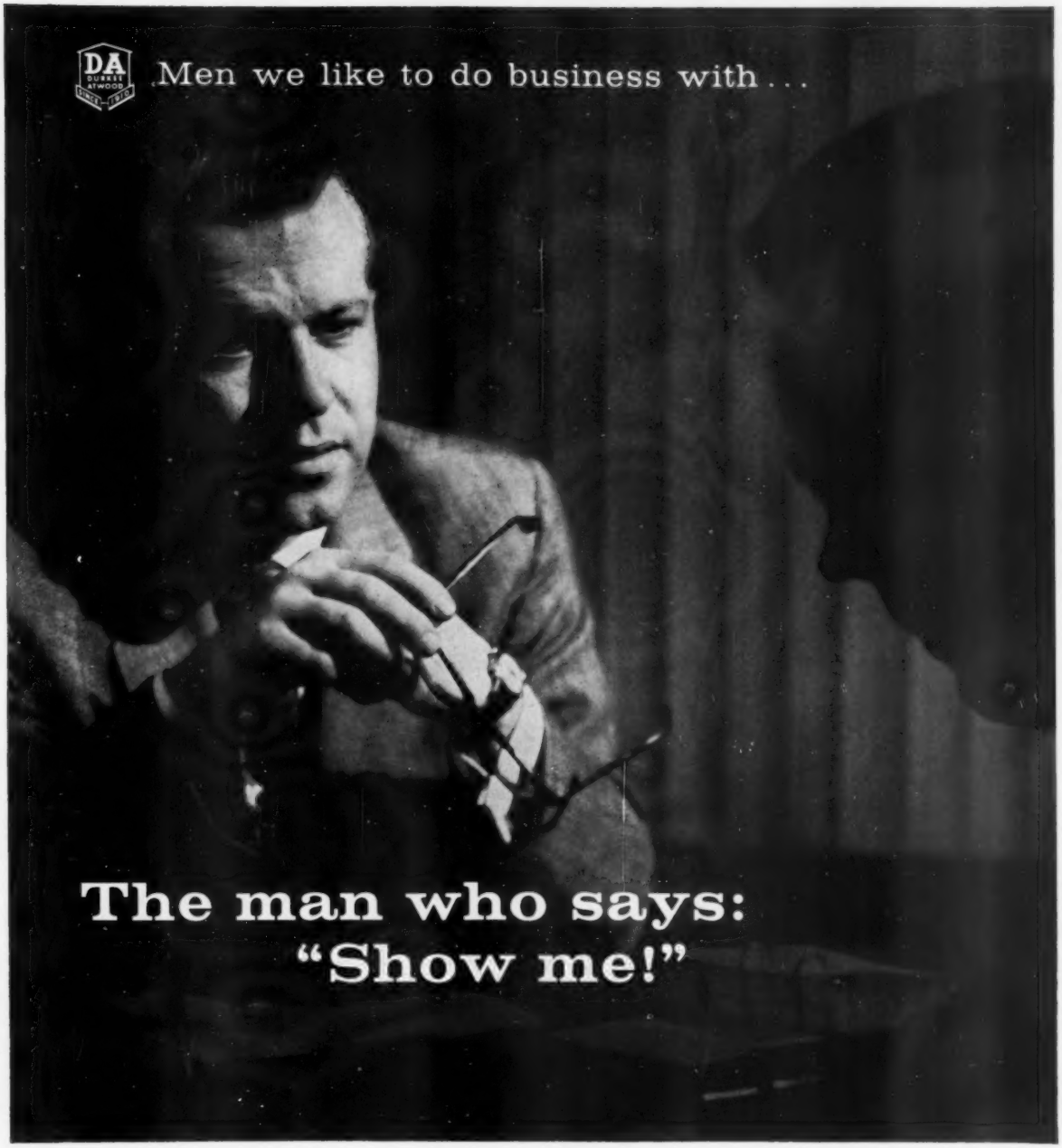
BEARING SECTION

REFERENCE FILE

ABSTRACTS

DEPARTMENTS

Before going further, tear out a Reader Service Card which you will find opposite page 64. Fill it out as you read and mail it when you're done. We'll act on your requests immediately.



Every day we welcome the opportunity to show operating and maintenance engineers how DURKEE-ATWOOD V-Belts will meet their needs better than any other V-Belt manufactured. We prove this claim in many ways: We demonstrate *Quality* to meet demanding needs, quality that engineering and constant research have developed and severe usage has proven . . . We tell about our prompt *Service*. When you need special attention and help "right now," we're Johnny-on-the-spot . . . We explain fully how DURKEE-ATWOOD V-Belts provide real money *Savings* . . . DURKEE-ATWOOD, one of America's pioneer V-Belt manufacturers, offers a complete line of Multiple V-Belts, General Duty V-Belts and Steel Cable V-belts—built to *last!* We've got the belts to meet your needs exactly.

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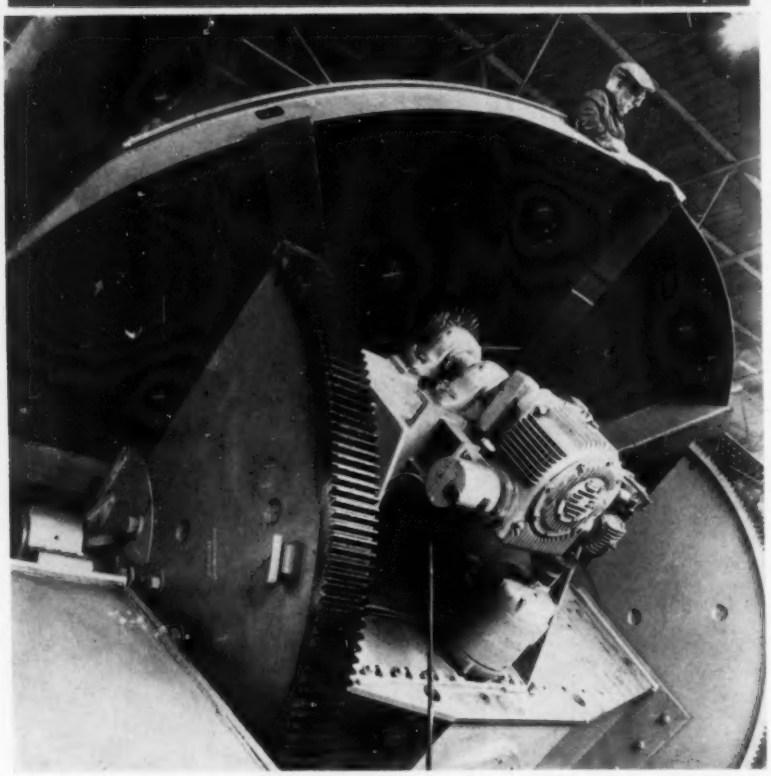
NEWS *from the power transmission field*



Synchronized motors tilt massive table

MILWAUKEE, WISC.—The world's largest positioner is now at work for Bucyrus-Erie of Milwaukee, producer of some of the world's largest shovels. Bucyrus-Erie is using the positioner for welding large frames for power shovels.

The machine stands 13 ft., 9-½ in. high with table horizontal, is 19 ft. wide at the base with two base pads (11 ft., 4 in. long and 3 ft., 8 in. wide.) It has a capacity of 200,000 lbs. at 24 in. center of gravity and 24 in. eccentricity.

Two synchronized 25-hp motors are used to drive the tilt, which is an innovation over the usual arrangement where a single motor and cross shafts are used to supply power to the tilt gears.

This mammoth unit was built by the Plainfield, N. J., Division of Worthington Corp., and weighed 65 tons when it was shipped to Milwaukee.

Hewitt-Robins expands

STAMFORD, CONN.—Hewitt-Robins International, S. A., new Brussels subsidiary, will direct sales and manufacturing in England, Holland, France, Italy, Germany and Japan.

Ball and roller bearings standards published

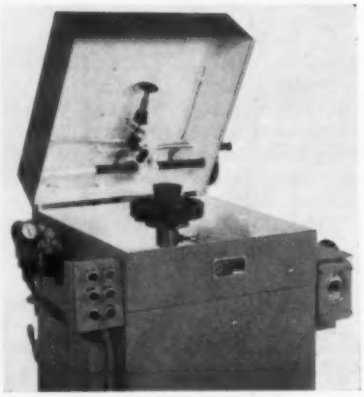
NEW YORK, N. Y.—A new American Standard method of evaluating load ratings for ball and roller bearings has been established, providing a uniform capacity rating system for bearings made by all manufacturers. Standard B3. 11-1959, published by the American Standards Association, is international in scope since it is identical in all major technical respects to ISO Recommendation 76 of the International Organization for Standardization covering static testing of bearings and the latest draft proposal covering dynamic testing.

The Standard establishes uniform test procedures and statistical methods for determining load-carrying capacity and expected fatigue life of both ball and roller bearings. It covers dynamic and static capacity of radial and thrust types and contains definitions of bearing life, basic load rating, equivalent load, basic static rating and static equivalent load. It also gives formulae for calculating these for different types and sizes.

Standard B3. 11-1959 was approved, prior to acceptance by the ASA, by associations of producers and users, by engineering societies and by government agencies. Standards were drawn up over a ten-year period by the Anti-Friction Bearing Manufacturers' Association, based on extensive experimental work in Europe.

Copies of the Standard are available at $1.75 per copy from the American Standards Association, Dept. PR 81, 70 East 45th Street, New York 17, N. Y.

Machine helps automate gear finishing



ROCKFORD, ILL.—An interesting improvement in gear deburring is represented by the unit shown at left, which has now been in successful operation under normal manufacturing conditions for over a year.

This machine is a semi-automatic, self-contained unit. It removes machining burrs from spur, helical and bevel gears. The work spindle rotates the gear at the desired speed and the floating wheel spindle allows the wheel to follow the gear tooth profile automatically. It deburrs the entire form, with no need for change gears,

followers or templates, and is thoroughly efficient regardless of the Brinell hardness of the gear involved.

Obvious production advantages lie in the keeping of modifications and maintenance at a minimum, so that the machine is extremely versatile, and in the fact that unskilled operators are perfectly capable of setting up and operating the machine. The unit may be adapted to low production runs as well as for large lot production, and high production is further aided by the uniform pace automatic cycling of the machine, where the operator has only to load and unload the piece.

The manufacturer, Redin Production Machine Co., reports impressive cost reduction figures.

MPB announces new research center

KEENE, N. H.—Nearing completion at Keene is the new MPB Research Center, according to Horace D. Gilbert, president of Miniature Precision Bearings, Inc. The Center will be devoted to research and development and for new products manufacturing in the precision metal working field.

The new building, to occupy 40,000 square feet, will be located close by the MPB plant, completed in 1956, which was the first plant designed exclusively for the production of miniature ball bearings. The Center will develop new approaches to precision bearing design and applications to meet instrumentation standards in defense and industrial production. The development of new production and testing equipment is also to be undertaken.

ASLE-ASME to meet

CHICAGO, ILL.—Sixth annual Conference on Lubrication jointly sponsored by the American Society of Lubrication Engineers and the American Society of Mechanical Engineers will be held at the Sheraton-McAlpin Hotel in New York City on October 20-22.

The Conference is aimed primarily at those concerned with research and development in the bearings, gears, seals and related lubrication fields.

MEN *of the power transmission industry*

ASME Junior Award goes to Worthington engineer

HARRISON, N. J.—Victor Salemann, research engineer for Worthington Corp.'s Harrison Div., is the winner of the American Society of Mechanical Engineers' 1959 Junior Award. Presentation was made at the Society's semi-annual meeting recently in St. Louis. The award, made each year for the best technical paper published by an associate member of the Society, was won by Salemann for his article "Cavitation and NPSH (Net Positive Suction Head) Requirements of Various Liquids."

Salemann was born in Yugoslavia, educated in Germany and the United States. He holds an engineering degree from Stevens Institute of Technology.

Picture above shows Salemann receiving the award from Glenn B. Warren, president of ASME.

Executive appointments at Eaton Mfg.

CLEVELAND, OHIO—Two executive changes within the Eaton Mfg. Co.'s family of divisions and subsidiaries were recently announced.

J. H. Burling, formerly assistant comptroller of Fuller Mfg. Co., was elected to the office of secretary-treasurer of this Eaton subsidiary. Burling will also serve as secretary of the Shuler Axle Co. of Louisville, Ky., a wholly-owned Fuller subsidiary. Fuller is a prominent producer of transmission, torque converters and remote controls used by manufacturers of on- and off-highway trucks and industrial machinery.

Announcement was made the same day of the appointment of Lawrence R. Gartung as chief industrial engineer of Eaton's Saginaw division. Gartung has been chief industrial engineer of Eaton's Aircraft Div. in Battle Creek, Michigan. The Saginaw division manufactures engine valve tappets, hydraulic valve lifters, control valves and anti-friction ball-bearing screws for internal engines in many fields.

Cox heads urethane product sales at Dayton Rubber

DAYTON, OHIO—Allan W. Cox is the newly-appointed director of urethane product sales for The Dayton Rubber Co. Cox will coordinate sales of all urethane products of all divisions with the exception of cushions and pillows, according to C. M. Christie, president.

Marketing activities in urethane products will be closely tied to those of American Latex Products Corp., Hawthorne, Calif., a wholly-owned Dayton Rubber subsidiary.

Chain Belt names three division executives

MILWAUKEE, WISC.—Chain Belt Co. has announced three executive promotions in its Springfield and Worcester, Mass., plants.

Roland V. Poisson, sales manager of the company's roller chain division at Springfield, has moved to Chicago as manager of the district sales office there. Replacing Poisson at Springfield is Joseph W. Cox, formerly sprocket sales manager at the Worcester plant. William E. Kennedy, formerly sales promotion and training supervisor at Worcester now becomes sprocket sales manager, replacing Cox.

Poisson, Cox and Kennedy joined Chain Belt Co. in 1944, 1940 and 1945 respectively.

Kern named vice president of marketing for MPB

KEENE, N. H.—Richard I. Kern was recently named vice president of marketing for Miniature Precision Bearings, Inc., Keene, N. H. Announcement was made by Horace D. Gilbert, company president.

Kern joined MPB in 1953 and served as western manager with headquarters in Santa Monica, Calif., until 1956 when he was named general marketing manager of the corporation. He was assistant sales manager of Atwood Vacuum Machine Co. prior to joining MPB.

Emerson Electric names Lindgren

ST. LOUIS, MO.—Richard Lindgren, former regional sales manager of The Lincoln Electric Co., will assume management of motor sales for The Emerson Electric Mfg. Co., effective immediately. He also will direct motor sales for Emerson's Colorado Springs subsidiary, Emerson-Western Co.

O. D. Metz, who has been manager of motor sales for the company, now becomes assistant to the general sales manager.

Hercules names sales director

CANTON, OHIO—William F. Humphrey, midwest district sales manager for Hercules Motor Corp., has been promoted to director of sales, according to William L. Pringle, Hercules president.

Humphrey has served as branch manager, Western retail sales manager, oilfield sales division manager, and midwest district sales manager since joining Hercules in 1940.

Bain

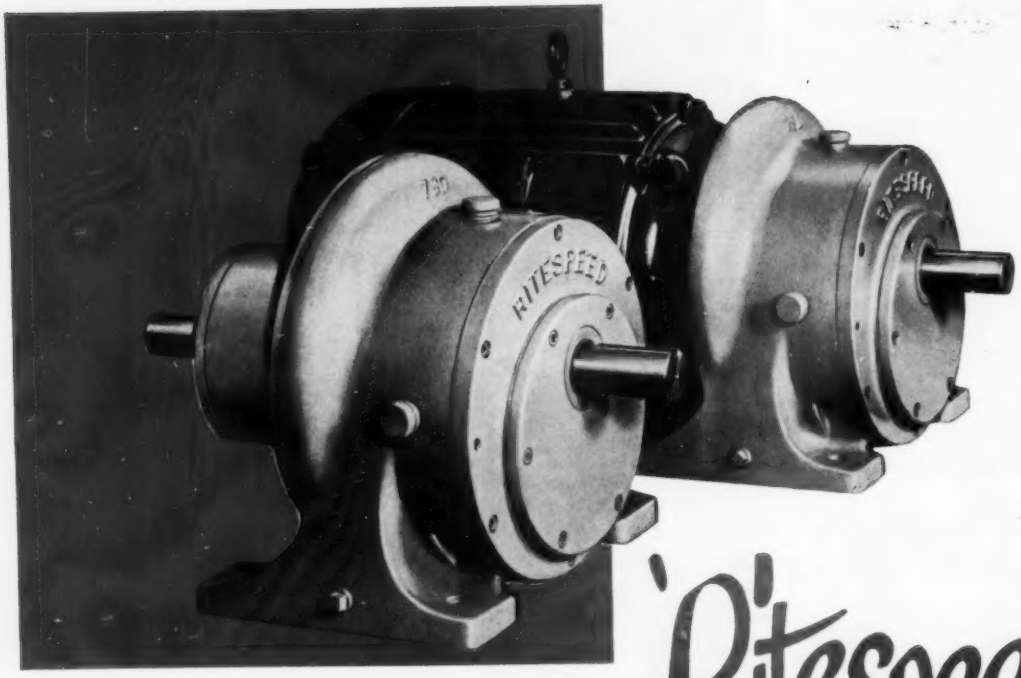
Leonard

Bain, Leonard promoted at American Pulley

PHILADELPHIA, PA.—Reorganization of American Pulley Co.'s production and engineering enterprises includes the appointment of Charles E. Bain to the position of general works manager, and the promotion of W. L. Leonard to a new post as chief engineer, power transmission equipment.

Bain, who had been manager of manufacturing for American Pulley, joined the company in 1952. He will now have complete charge of engineering and manufacturing.

Leonard also joined the company in 1952 and was recently assistant manager of power transmission sales.



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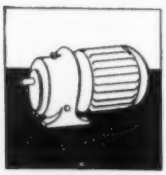

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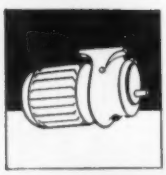
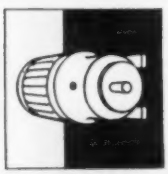


CEILING MOUNTING



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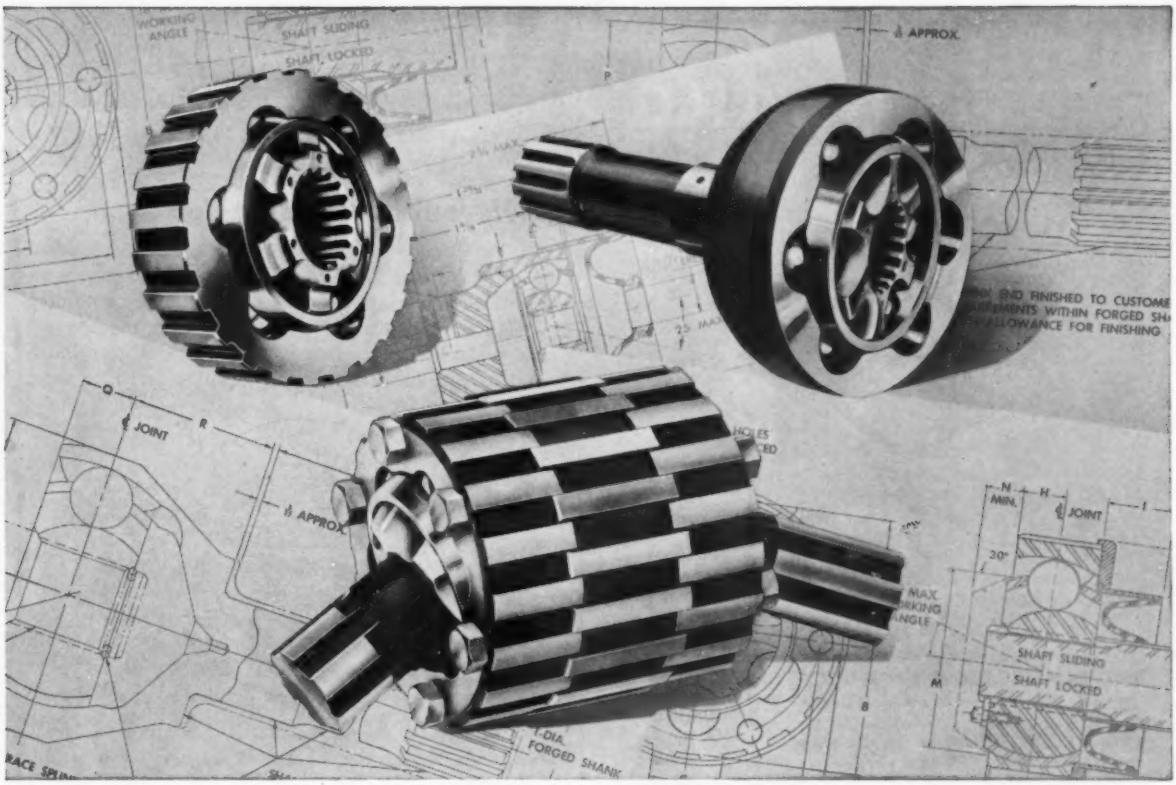

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Rzeppa universal joints are available in a wide variety of sizes, angles, speeds and styles . . . designed for front drives, articulating axles, propeller shafts, and scores of special applications. For information on their many advantages write to—

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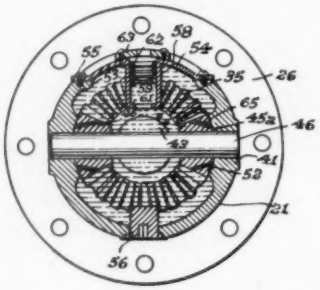
PATENTS

Differential transmission

U. S. Patent No. 2,869,399; *Everett G. Miles, Rockford, Ill.*

Case and side gears form a sealed chamber containing the differential pinions. Lubricant filling the housing has a much higher viscosity than normal gear lubricant used to lubricate the drive pinion and ring gear.

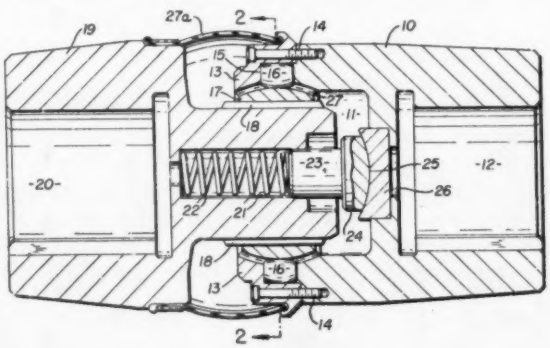


It is sufficiently viscous so that it does not flow freely into and out of the intertooth spaces between the differential pinions and side gears and thus impedes rotation enough to let more torque to be transmitted to whichever of the side gears is travelling at the lowest speed. The case is pressurized to assure adequate lubrication of the side gear and pinion teeth.

Constant-velocity coupling

U. S. Patent No. 2,867,998; *Lothar S. Heym, Youngstown, Ohio.*

Driving member has a spherical socket at one end with a plurality of circumferentially spaced parallel slots



and a roller in each slot. Driven member's projecting end has an arcuate grooved spherical ring gear which engages the rollers. A spring-loaded plunger in the driven member bears against a spherical surface on the driving member to hold all parts in correct relationship.

EDITOR'S PAGE

THE ORIGINAL

JAMES WATT

STEAM ENGINE . . .

David R. Cartwright
editor

. . . and its predecessor, the Newcomen atmospheric engine were masterpieces of their time and still might be able to give us a few ideas for today. The Newcomen engine was built in 1712 and the Watt engine in 1799.

Newcomen used steam, as today, but instead of applying steam at the bottom to move the cylinder up, he injected a squirt of cold water into the steam and let atmospheric pressure at the top move the piston down into the partial vacuum created.

This is backward, but sensible, and we wondered if we might not be able to review a lot of our designs today with the basic principle reversed as Watt did.

The Watt engine thus outmoded the Newcomen engine. It had a 60 hp rating. Its piston was first attached to an overhead rocker beam to lift water out of a well. Later it turned a sun and planet gear set, and still later it became a complete rotary engine as shown.

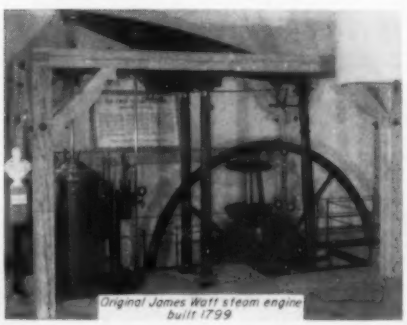
It was Watt who studied power of horses and figured that one horse could lift 33,000 lbs a distance of one ft per min, so he rated his engines 20 horses, 60 horses, and so on.

These two units and many other old timers are housed in the new Hall of Progress at The DoALL Company, Des Plaines, Ill. We are grateful for their letting us show them to you.

Dave Cartwright

Editor

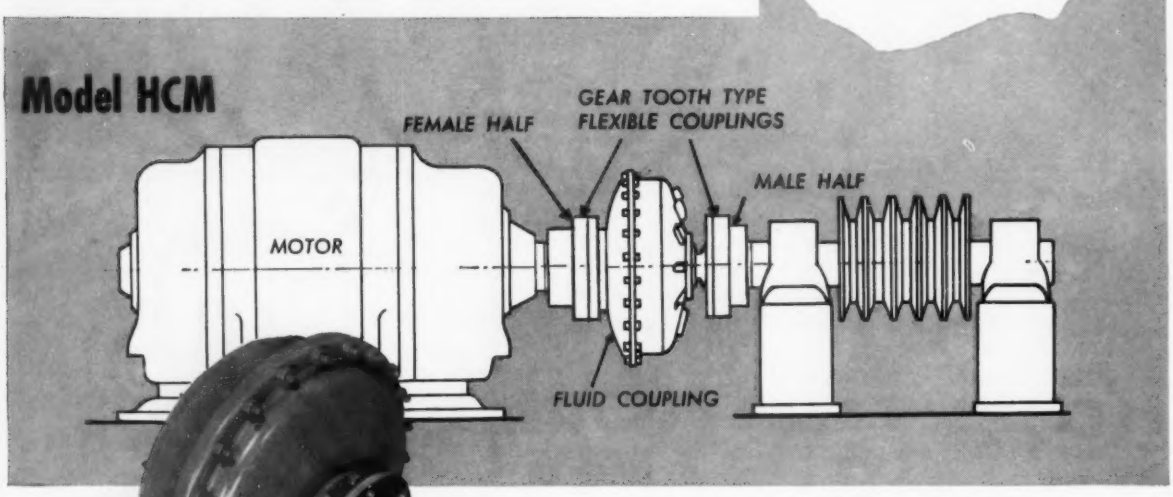
Newcomen atmospheric engine (replica) built 1712



Original James Watt steam engine built 1799

MEMO to drive line designers:

Twin Disc Fluid Couplings give you all the benefits of fluid drive *PLUS* easy installation...



Twin Disc Fluid Coupling

Twin Disc HYDRO-SHEAVE® Drive

Working between engine or motor and driven equipment, Twin Disc Fluid Couplings provide performance benefits aplenty . . . benefits such as satin-smooth power flow, protection against shock loads, full transmission of input torque, and elimination of engine lugging and motor burnouts.

Here's another big advantage that's sometimes overlooked: Twin Disc Fluid Couplings are exceptionally easy to apply and install. They come in a wide variety of input-output combinations to match any hook-up requirement. A good example is the Model HCM coupling shown above.

Model HCM features an input flange and a flanged output shaft that connect between two halves of a gear-tooth type flexible coupling. The result is an extremely compact arrangement with minimum distance between driving and driven shafts (see diagram). Model HCM is available in nine sizes from 7.4S to 21 with capacities from ¾ to 500 hp.

A special integrated power transmission package is Twin Disc's HYDRO-SHEAVE® Drive. This low-cost conversion device has a tapered hub that permits the use of a wide range of quick-detachable V-belt sheaves. It can be installed in less than five minutes. Available for motors and engines in the ¾ to 50 hp range, the HYDRO-SHEAVE comes filled with hydraulic fluid and ready to install.

In all, Twin Disc offers design engineers a choice of ten fluid coupling models including a disconnecting-type and a fluid power take-off.

Write our Rockford office for Bulletin 144-D.

TWIN DISC

TWIN DISC

Friction Clutches and Fluid Drives

TWIN DISC CLUTCH COMPANY

Racine, Wisconsin

Hydraulic Division, Rockford, Illinois

For More Information Circle No. 26 on the Reader Service Card.

NEW HIGHER PERFORMANCE FOR FORMCHROME* SPRAGS

On over-running clutch applications, Formsprag clutches have always provided greatest torque capacity for size and weight, no measurable backlash, extreme precision and long trouble-free life. Now! With newly designed Formchrome sprags, the best over-running clutches provide users with even higher performance.

Here's why! The new Formchrome sprags are made of hardened high carbon alloy steel with chromium diffused into the surface to form a chromium-carbide alloy. Thus, the sprag is corrosion resistant, and has high hardness and abrasion resistance similar to tungsten carbides. Result—sprag geometry is retained over a longer period and clutches can be used on higher over-running speeds. The Formchrome sprag is exclusive with Formsprag—no other clutch manufacturer can offer you its performance advantages.

Typical of the higher performance users can now receive from Formsprag clutches is this specific example: A Formsprag clutch using Formchrome sprags was installed in the reaction member of a torque converter and a competitive clutch in another. The competitive clutch showed excessive wear after the equivalent of one year of operation. The Formsprag clutch was run 50% longer and still showed only negligible wear.

There is a Formsprag clutch for every application—from business machines to aircraft. Standard clutches cover a wide range of uses and are described in the Formsprag Catalog . . . send for your free copy. However, to meet unusual requirements, Formsprag engineers will modify a standard clutch or design a special—send your application details.

FORMSPRAG COMPANY
23587 Hoover Road, Dept. 102
Warren (Detroit), Michigan

In Canada: Renold Chains Canada, Limited
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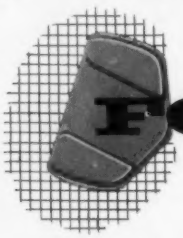
Distributors in Principal Cities

*Formchrome sprags are produced under a patented process. The use of this process in the manufacture of over-running clutches is exclusive with Formsprag.



FORMSPRAG CLUTCHES

World's Largest Exclusive Manufacturer of Over-running Clutches

TYPICAL APPLICATIONS WHERE FORMCHROME SPRAGS HAVE PROVEN SUPERIOR PERFORMANCE

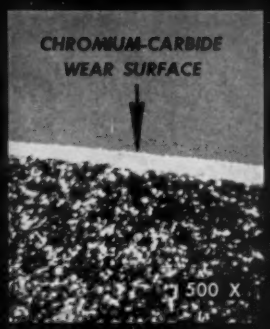
1. Used in operating submarine missile (Regulus II), Formsprag clutch allows alternator to over-run the hydraulic driving mechanism.
2. Backstop clutch on belt conveyor handling bauxite ore is subjected to higher over-running speed, extreme abrasive dust and hot weather—has been in operation a year.
3. Starter clutch for aircraft ground support system allows high-speed gas turbine to over-run starter unit.

For additional information on how Formchrome sprags assure better performing clutches, write for technical paper "Formchrome Sprags".

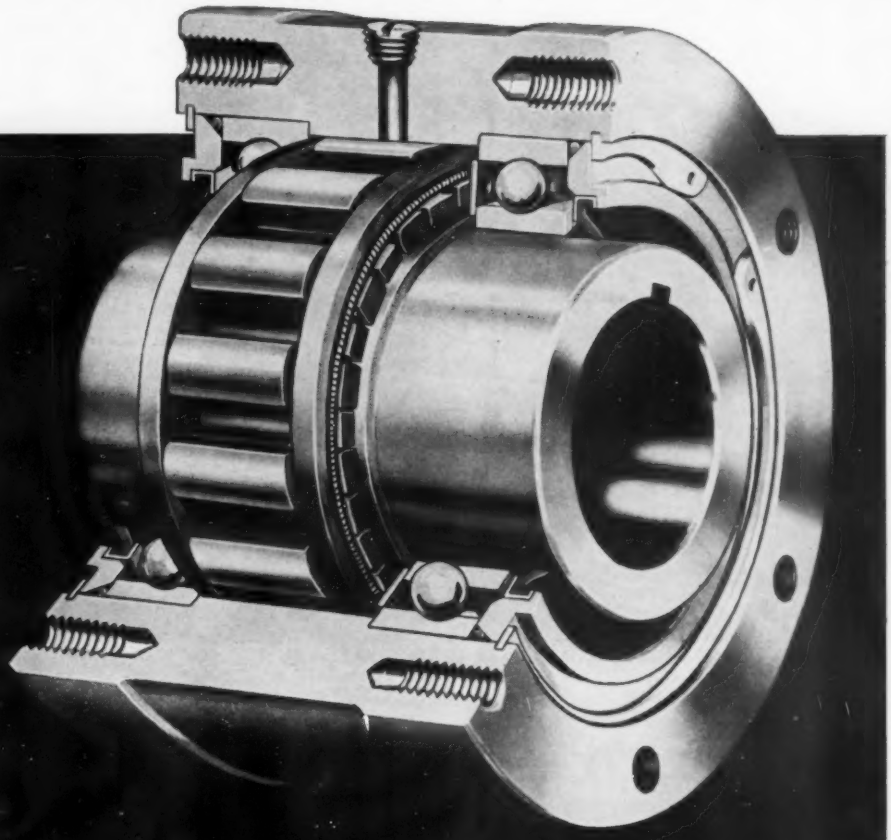
HERE'S

The Formsprag clutch consists of a full complement of shaped sprags, or wedges, located between concentric inner and outer races. Power is transmitted from one race to the other by the wedging action of the sprags. Each sprag is so shaped that dimension AA is greater than BB. Rotation of one race in the "driving" direction causes the sprags to wedge, transmitting torque in full from one race to the other.

FORMSPRAG OVER-RUNNING CLUTCHES WITH



Micro-photo showing chromium-carbide wear surface (1900 Vickers—80 R_c) of Formchrome sprags. Chromium is diffused into high-carbon alloy steel sprag (62R_c).



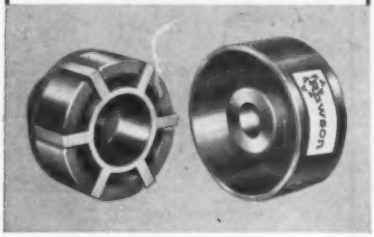
OVER-RUNNING · INDEXING BACKSTOPPING

HOW IT WORKS

An expanding coil spring keeps the sprags in light contact with both inner and outer races. There is thus no lost motion, the driving torque being instantaneously transmitted between races. The Formsprag Clutch is so designed that it will transmit a greater torque in relation to its size and weight, than any other comparable type of clutch . . . specify Formsprag on over-running, back-stopping and indexing applications.

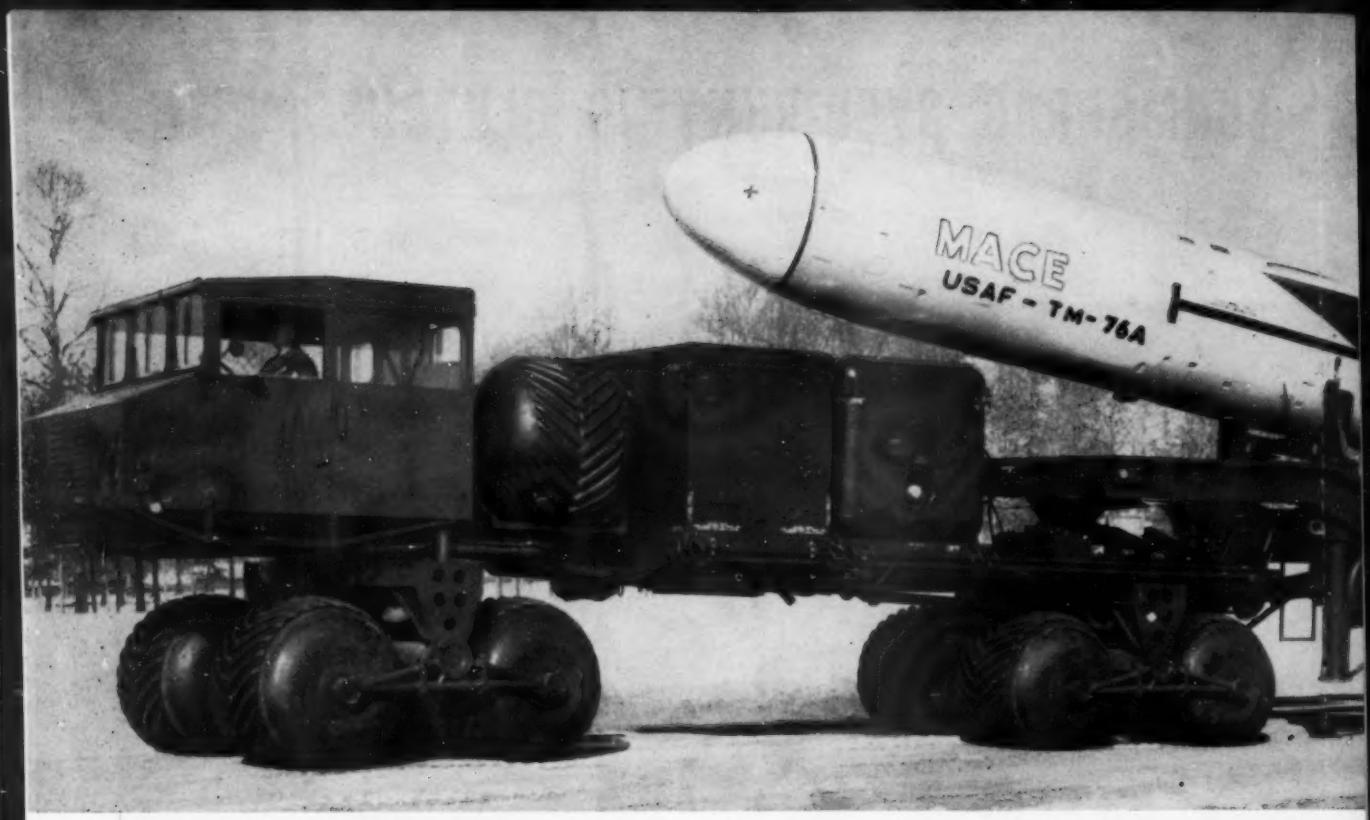
Forcing a ball or roller into a curved, wedged space is an old over-running clutch principle. The sprag is, in effect, a "roller" of increased diameter with greater contact surface in a given annular space. Formsprag Clutches engage at constantly changing contact points. Clutch life is prolonged and backlash eliminated. Also, with the inclined surfaces discarded, more sprags can be inserted to increase torque capacity.

RAWSON FOR NO-LOAD STARTS



Specify Rawson Automatic Centrifugal Clutches and Clutch Couplings. They protect the prime mover, eliminate need for costly reduced voltage starting equipment, permit use of less expensive smaller motors to start high inertia loads. Completely automatic and entirely mechanical in operation. Rawson clutches provide full overload protection, never need adjustment. Write for the new Rawson Clutch Catalog now.

For more information circle No. 32 on the Reader Service Card



Differential above axle lets driving wheels steer

BY W. H. THURN, JR., *Ground Support Equipment Design, Goodyear Aircraft Corp.*

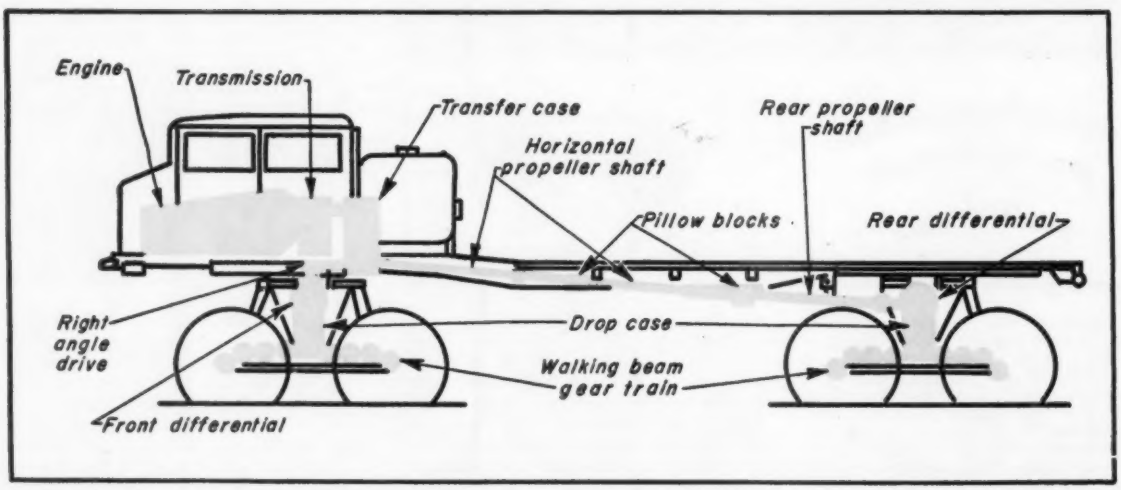


Fig. 1. DRIVE TRAIN of the MM-1 truck.

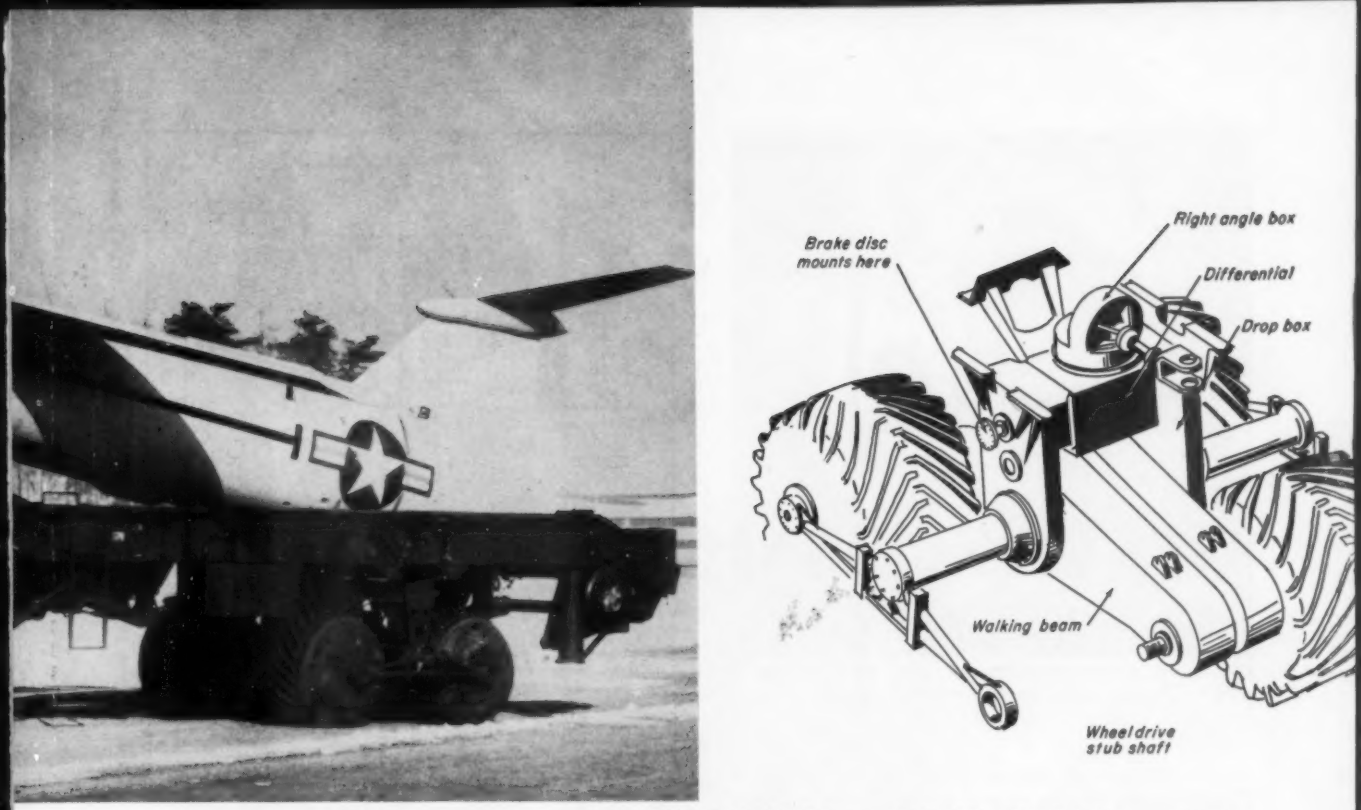


Fig. 2. SKETCH shows relationship of bogie drive components.

Differentials mounted above axle level permit both steering and transmission of power in a new flatbed truck. The driving differentials each have two output shafts. Each output shaft powers two wheels in four-wheel units called bogies. Differential action is transverse across wheel pairs.

Power flow from the air-cooled, 250-hp horizontally-opposed engine is through a semi-automatic, 4-speed transmission to a transfer case. From the transfer case, power is transmitted through propellor shafts to the drop boxes and differentials at the front and rear bogies. See Figure 1.

Power from the propellar shaft is transmitted to two gear boxes, called drop boxes, atop the differentials, then into walking beams (Fig. 2) that distribute power to the wheels. The walking beams support the inner ends of the wheels and contain gearing to transmit power (Fig. 3).

Input to the differential at the front bogie is through a right-angle gear box. This keeps the propellor shaft high enough to prevent any interference with swiveling of the front bogie for steering. Also, the right-angle gear box out-put shaft is on the same axis as the turning axis of the front bogie. Thus, the right-angle box serves as a swivel joint for transmitting power from the propellor shaft to the bogie. A large bearing between the gear box and differential case permits relative rotation.

Differentials Lockout

When traction is poor, normal differential action would prevent all but two of the eight wheels from driving. To prevent this, differential lockouts are used on all three differentials. The lockouts are jaw clutches which lock the differential carrier to one of the driven shafts.

Control of lockout is electro-pneumatic. A switch on the truck dash is flipped by the operator to energize a solenoid valve and operate an air cylinder at each differential to engage the clutches.

Transfer Case

The transfer case, Fig. 4, has several functions. First, it provides a power-take-off point for driving auxiliary equipment such as ground power generators or hydraulic pumps mounted on the truck bed. The take-off shaft is on a line with the input shaft and is engaged by an air-cylinder-shifted jaw clutch. The jaw clutch is interlocked with the truck's 4-speed semiautomatic transmission to keep it from shifting unless the transmission is in its 1:1 ratio.

Second function of the transfer case is to drop the power from the level of the transmission output shaft to a point below the truck bed. This is done with helical gears with 1:1 ratio and results in a drop of 20 in.

Third, the transfer case divides the power between front and rear bogies. This is done with a conventional differential. This differential is one of the three which may be locked out by shifting a jaw clutch.

Fourth function is to provide a single point for application of a parking brake to lock all eight wheels. Drum for this brake is between input and output shafts. Differential lockout system is used in conjunction with the parking brake.

The MM-1 truck is the basic, multipurpose vehicle

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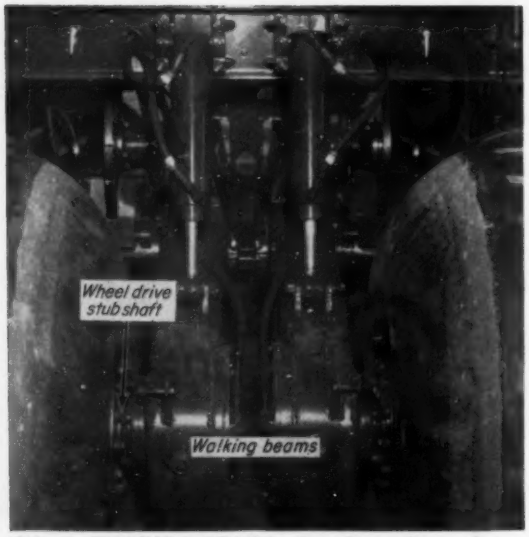


FIG. 3. WALKING BEAMS, also shown in section at bottom of page, permit articulation of wheels.

used in the ground support system of the Air Force TM-76A Mace Missile. One is used to carry auxiliary power supply units for the missile and tow the Translauncher—a semitrailer of construction similar to the MM-1 truck which transports the missile main body and wings to the launching site and then serves as a launcher for the assembled missile.

Designed to weigh less than standard military trucks of similar capacity, the MM-1 weighs approximately 15,000 lb and has capacity in excess of its own weight. Many of the structural parts are aluminum. The vehicle is air transportable in a Lockheed C-130 or larger aircraft.

System contractor for the Mace missile is the Martin Co. Goodyear Aircraft Corp. is prime contractor for guidance and ground support equipment. Four Wheel Drive Auto Co. builds the truck.

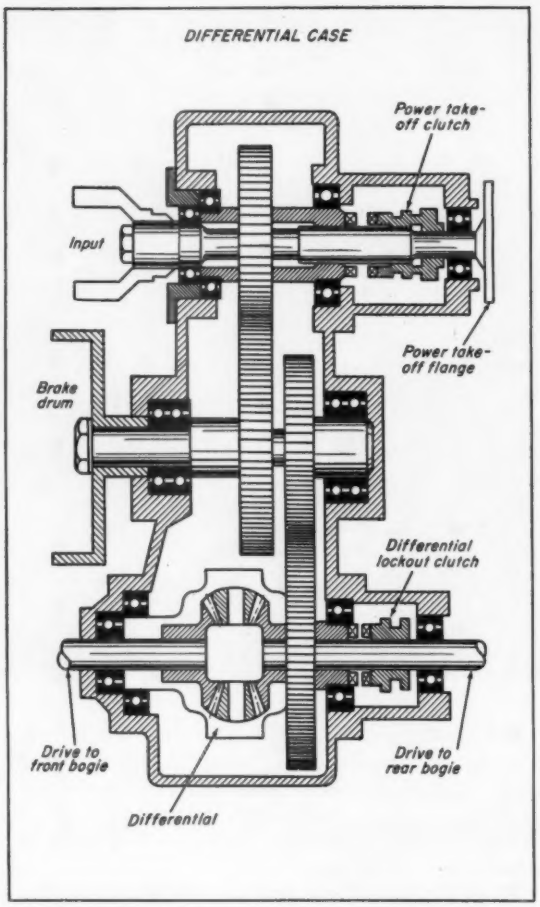
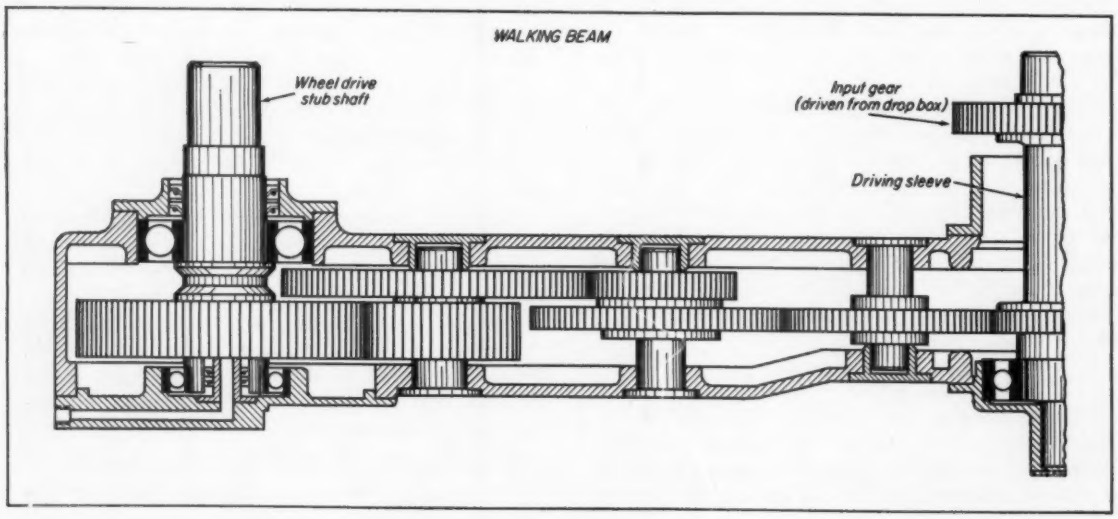


Fig. 4. SECTION through transfer case. Small piston pump provides lubrication when PTO is operating. Engagement of PTO disengages lower gears, so there is no splash. Pump is driven by an eccentric on the PTO shaft. REAR VIEW of bogie (top left) shows walking beams between tires with little room left over.



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FALK Motoreducers driving log conveyor and refuse conveyor at the modern mill of The Bohemia Lumber Company, Culp Creek, Oregon.

FALK *all-steel* Motoreducers give you longer service life

Whether your load conditions are normal or heavy, the extra rigidity of all-steel construction (more than twice that of cast iron) maintains better alignment of revolving elements under load...a vital factor in prolonging the service life of gears and bearings.

And if your installations are subject to shock loads, or accidental external impacts, you're way ahead when you install Falk All-Steel Motoreducers. These rugged units do not destroy themselves by tearing off their feet under jamming overloads, nor are their housings subject to cracks which both dissipate the vital lubricant supply and allow revolving elements to get out of alignment.

All-steel construction is one of the built-in extras that you get in Falk Motoreducers. Others include: (1) 12 to 15% reserve load-carrying capacity in the gears (by AGMA standards), thanks to exclusive Falk extra-depth, high pressure angle helical gears; (2) maximum mechanical efficiency (98½% per gear mesh, under full load); (3) your choice of standard units (horizontal, vertical or right angle) to fit your precise requirements.

HORSEPOWER RANGE: to 75 hp . . . STANDARD OUTPUT SPEEDS: 780 rpm (high) to 1.2 rpm (low).

Prompt delivery from distributor stocks, or from warehouse or factory. Ask your Falk Representative or Authorized Falk Distributor for ***Bulletin 3100.***

THE FALK CORPORATION, MILWAUKEE 1, WIS.

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

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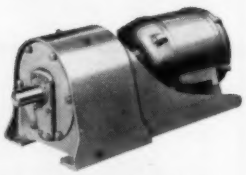
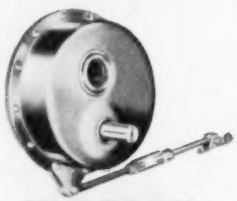


THE FALK ALL-MOTOR MOTOREDUCER
...the original All-Motor unit



THE ALL-STEEL FALK SHAFT MOUNTED DRIVE

Torque ratings to 41,000 lb-in at low speed shaft. Also available in flange-mount design.

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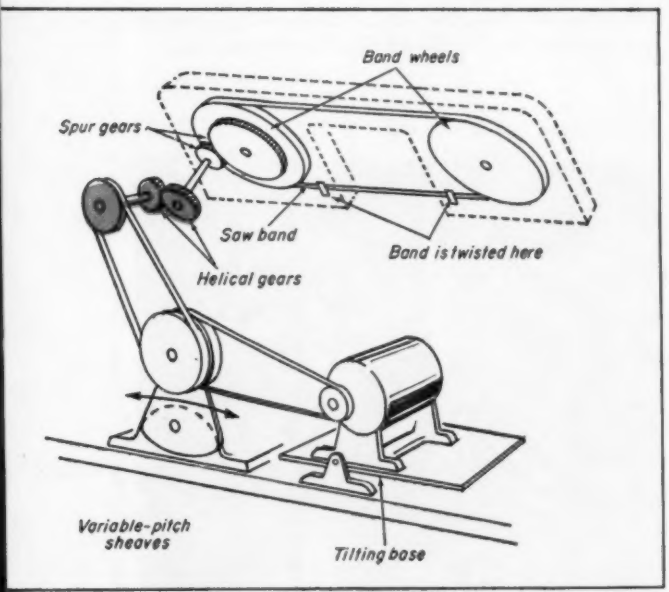
IDEAS FROM THE FIELD

Helical gear pair makes 52 degree drive



HELICAL GEARS at 52 deg angle transmit 3 hp.; angle drive is needed to let saw band and supporting frame be raised clear of the workpiece while limiting amount of twist in the saw band.

HELICAL GEARS with shafts intersecting at a 52-deg angle power the blade drive on a metal-cutting bandsaw. Although this is unconventional, designers feel it is the most economical way to do the job and know that it works.

This angle was necessary for two reasons: First, because the saw band swings to a horizontal position, the cutting head had to be tilted so as not to interfere with work pieces; second, if the head were tilted to vertical, the band would have to be twisted 90 deg to keep the teeth headed into the work.

Another problem was the need to feed the saw into the work. This is done by pivoting the entire cutting head around the drive shaft axis of the input gear of the helical gear pair.

Helical gears when used this way have very little tooth contact area. In this case, manufacturers run the gearset in for 8 hours to get additional contact area by wear.

The entire blade drive consists of a squirrel-cage motor on a tilting base which drives one of a pair of variable-pitch sheaves on a countershaft, the other

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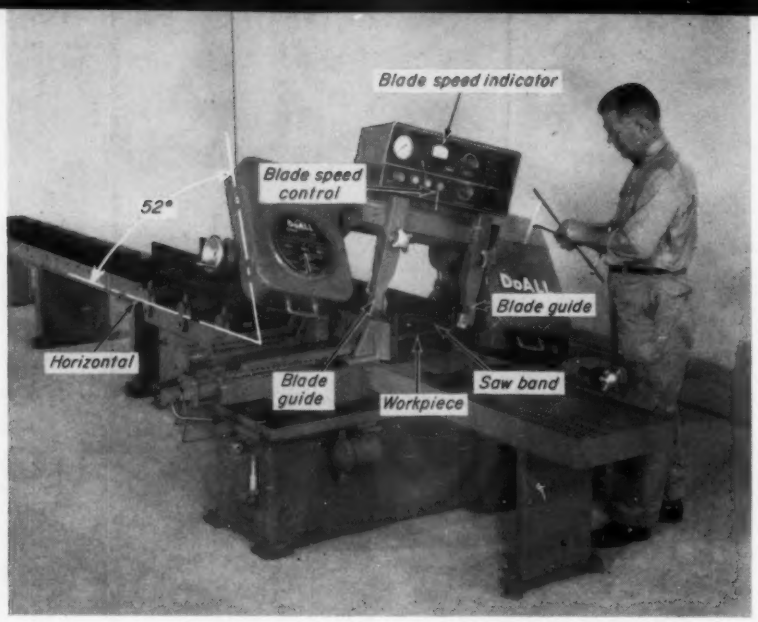
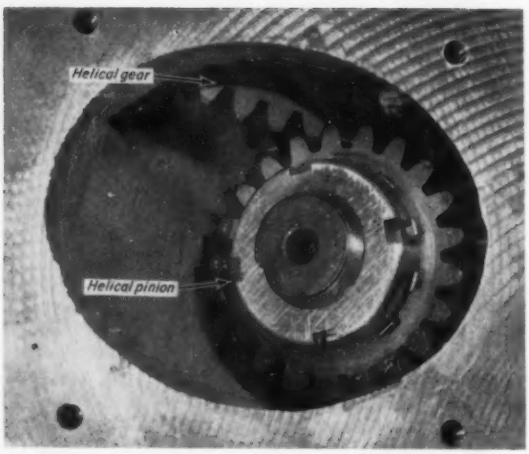
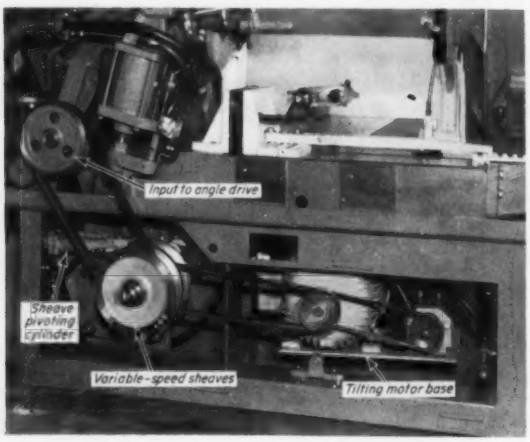


METAL CUTTING BANDSAW, Model C-68, uses helical gears in unconventional manner to very good advantage.

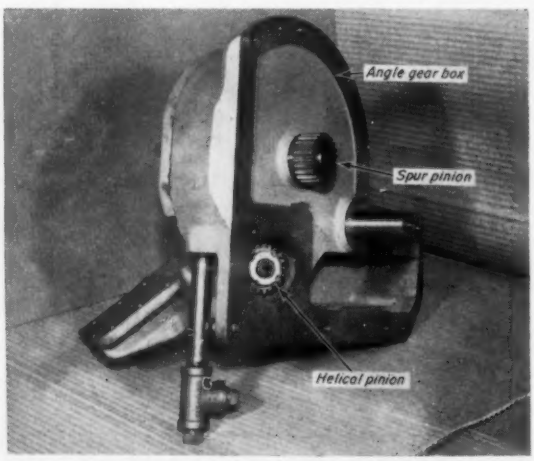


CLOSEUP OF HELICAL GEARS, above, taken through hole in gear box. Complete gear box is below. Spur pinion outside box meshes with gear to drive band wheel.

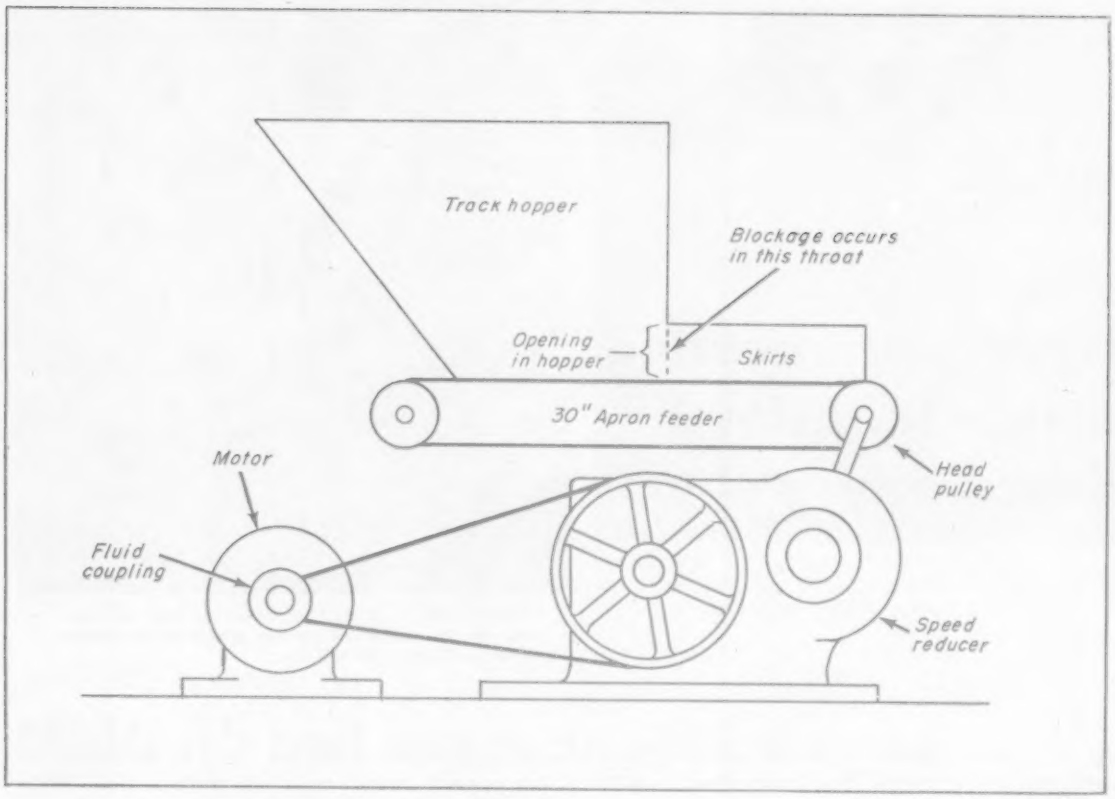


sheave which drives the helical gear set through a wide range V-belt, and a gear box containing the helical gear set and additional spur gears for speed reduction. Total reduction of helical and spur gears is 27:1. The countershaft on which the variable-pitch sheaves are mounted is pivoted, and rotated by a hydraulic cylinder to vary speed. As the pitch of one sheave decreases, the other increases. This gives speed variation of about 6:1. Control valve for the hydraulic cylinder is mounted on the front of the machine to allow remote speed selection. A tachometer on the panel shows the speed selected.

Continental Machines Inc., Savage, Minn., makes this machine for The DoAll Co., Des Plaines, Ill.



VARIABLE-SPEED V-BELT DRIVE is input to helical gear set. Dual sheaves on common shaft give wide range of speed adjustment.



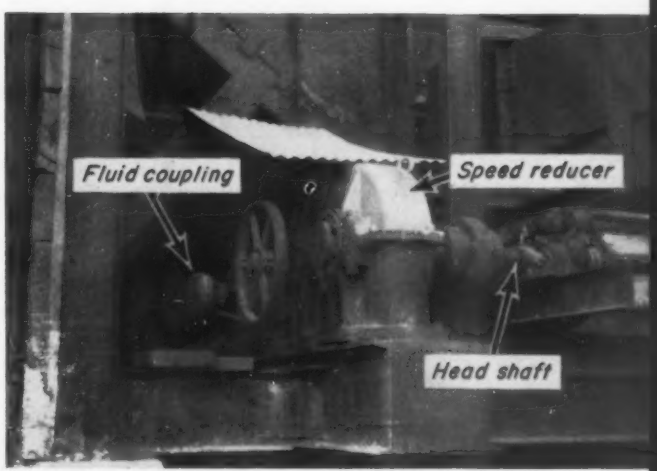
Fluid coupling stops bearing failure

FLUID COUPLING on an apron feeder drive motor stops breakage of bearings and headshafts when oversized pieces of material jam the apron. Also, slip of the coupling reduces drive motor hp from 25 to 15.

The apron feeder feeds blast furnace slag to a crusher. Feeder drive consists of a 15-hp, 1800-rpm, squirrel-cage motor driving through the fluid coupling and a three-stand V-drive to a speed reducer which couples to the headshaft of the feeder. Sheaves of the V-drive are 6.4 and 25.0 in. PD giving a reduction of about 4:1. Speed reducer is 42:1 giving headshaft speed of 10.64 rpm.

Installation of the fluid coupling modified the original drive and was simplified by using a unit with an integral sheave with concentric input and output shafts at the same end of the coupling. The input shaft is a sleeve bored for standard NEMA motor shafts. This way, installation of the fluid coupling and sheave is no more complicated than installing a sheave on the motor shaft.

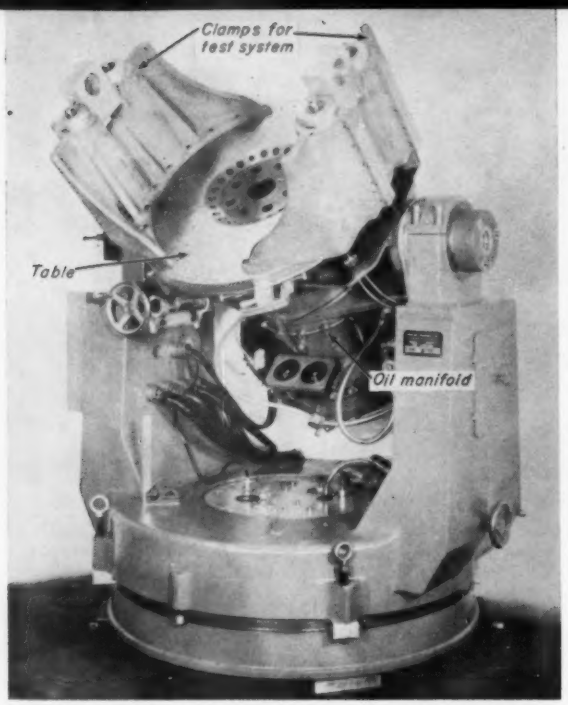
This installation was made by plant engineers at a plant of *The Buffalo Slag Co., Inc.*, Buffalo, N.Y.



HEADSHAFT AND BEARINGS on apron feeder broke when apron was jammed by oversize materials. Installation of the fluid coupling lets apron stop with no damage to components due to fluid slip.

IDEAS
continued

Hydrostatic bearing makes large load float freely



HYDROSTATIC BEARING lets table and mounted system on this guidance system platform be turned by motors of about 0.0005 hp.

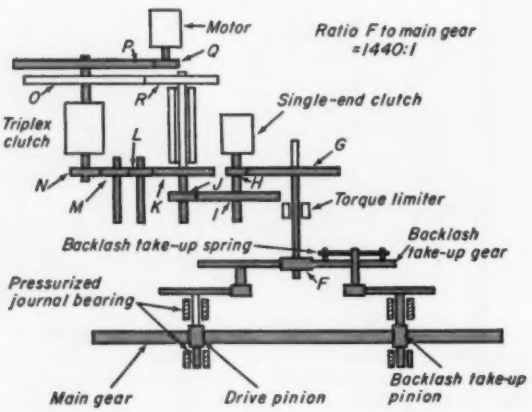
OIL AT 250 PSI "floats" a 3500-lb load so it turns easily with precise control. Small motors with outputs in the neighborhood of 0.0005 hp rotate the load. In addition to reducing friction, the bearing maintains alignment accuracy of ±2 sec of arc when tilted. This is necessary because the entire table and load may be tilted to 90 deg. The bearing supports a rotating test table for checking alignment of inertial components, and observing gyro and platform drift characteristics of navigation systems.

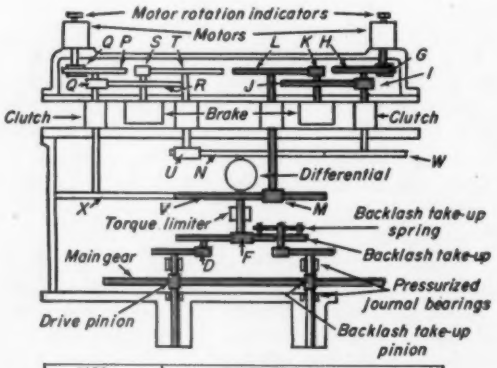
Rotating elements of the table weigh 3000 lb. The navigation system contributes another 500 lb. Oil is fed to the bearing through jets in the journal surface to support the turntable and center it. In addition to the pressure pump, a scavenge pump is used. Fluid is SAE viscosity number 10 motor oil. Since clearances in the bearing are quite small, oil passes through a 5 micron filter before delivered to the bearing.

Table drive is through precision gear trains by small synchronous motors. Two separate drive systems are used to drive the table at 1, 2, 3, 4, 8, and 24 times the earth's rotation rate (earth rotation rate = 0.250684 deg/min), plus a rate of 45 deg/min.

Drive system A provides 8 and 24 time rates. Input is 1800 rpm with minimum torque of 0.25 oz-in. from a single-phase motor. A small magnetic clutch selects

RATE	POWER FLOW
8X EARTH RATE	Q-P-N-M-L-K-J-I-H-G-F
24 X EARTH RATE	Q-P-O-R-K-J-I-H-G-F





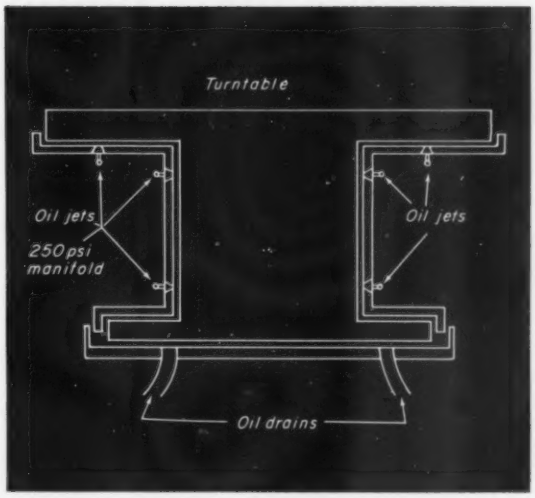
RATE	POWER FLOW
1 X EARTH RATE	S-LOCKED, GEARS-G-H-I-J-K-L-M-V-F
2X " "	G-NEGATIVE, GEARS-G-H-I-J-K-L-M-V-F O-POSITIVE, GEARS-O-P-Q-R-S-T-U-N-F
3X " "	K-LOCKED, GEARS-O-P-Q-R-S-T-U-N-F
4X " "	G-POSITIVE, GEARS-G-H-I-J-K-L-M-V-F O-POSITIVE, GEARS-O-P-Q-R-S-T-U-N-F
45 DEG./MIN.	G-POSITIVE, GEARS-G-H-W-N-F O-POSITIVE, GEARS-O-P-X-V-F

DRIVE SYSTEM A drives the table at 8 and 24 times earth's rotation rate. Power flow for 8x rate is shaded. DRIVE SYSTEM B drives table 1, 2, 3, and 4 times earth's rate, as well as at 45 deg./min. Power flow for 1x earth rate is shown by shading.

one or the other of two speeds. The clutch has one input shaft and two output shafts. One output shaft is concentric with the input shaft. In the diagram, input and one output shaft are at the upper end of the clutch. Second output shaft is at the bottom. For a speed of 8 times earth rate, the lower shaft is engaged; for 24 times, the upper shaft is engaged.

Drive system B provides rotations of 1, 2, 3, and 4 times earth rate, and 45 deg/min. Two synchronous motors with 1500 rpm, 0.25 oz.in. minimum torque power this system. The 5 speeds are selected by electrical selection of one motor or the other, and by controlling direction of rotation. Outputs of the two gear trains are fed through a small gear differential to the final gear reduction. Two small magnetic brakes lock out the gear train not being used. When the 45 deg/min speed is selected, both motors drive. The drive is then straight through the triplex clutches to gears *x* and *w*. For all other speeds, drive from the clutches is through the output shafts concentric with the input shafts.

Test platform designed and built by *Sterling Precision Corp., Instrument Div.*, Port Washington, N. Y.



PRINCIPLE OF HYDROSTATIC BEARING. Oil at about 200 psi is fed through manifolds to small holes or jets to support and center moving platform.

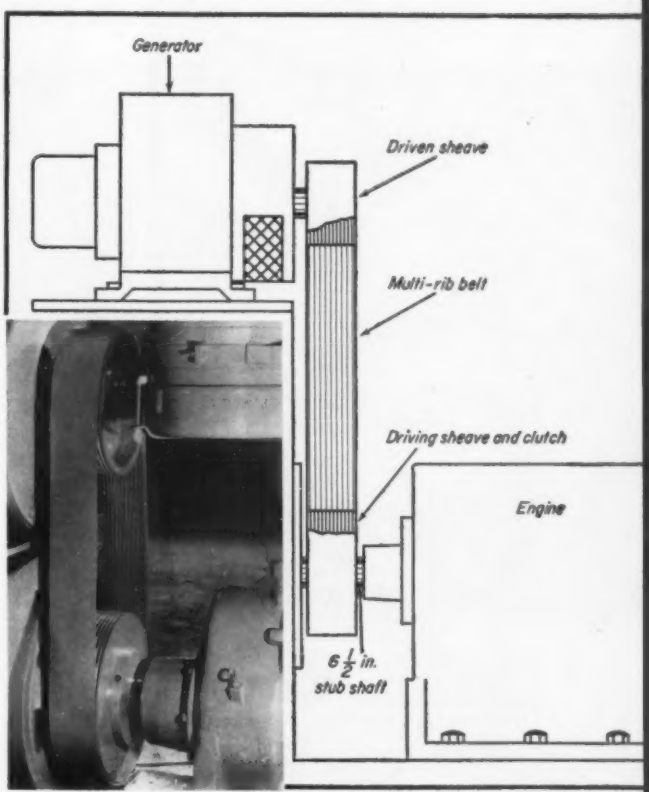
Multi-rib belt saves one-third space

TRANSMITTING 70 HP from a 6½-in. stub shaft using a conventional multiple-V-belt drive was the impossible job faced in the design of a rock crushing plant. The stub shaft is on a diesel engine which drives a generator to supply power to the crusher. A clutch was also necessary. This made the short shaft seem even less adequate.

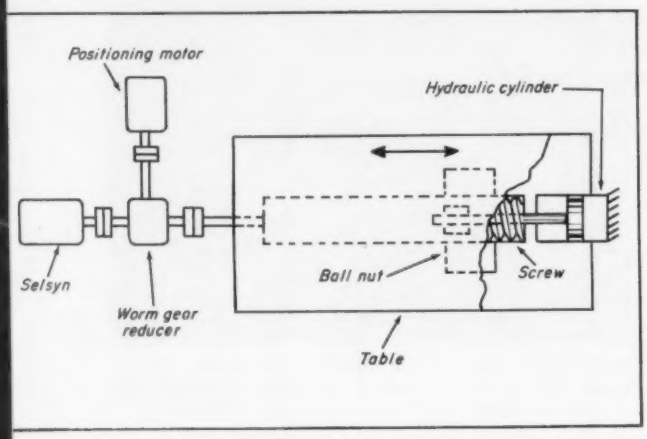
Solution to this problem is a special casting which serves as the clutch spider hub and sheave, used with a multiple V-ribbed belt only 4½-in. wide. This type of belt transmits the same amount of power as a multiple V-belt drive approximately 50% wider. The 62.5 KVA generator is mounted on a tilting base which serves as the belt takeup, above and in line with the engine. This results in a shorter center distance drive than could be had with the generator on the same level as the engine.

Center-to-center distance is 27.0 in. Drive sheave is 15.5 in. PD and driven sheave is 13.0 in. PD. This gives generator speed of 1200 rpm with the engine governed at 1000 rpm. Twelve grooves in the sheaves mate with 12 ribs on the one-piece belt.

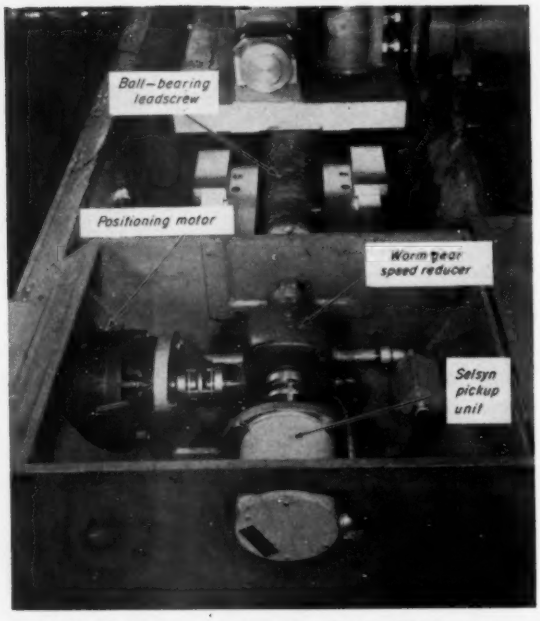
This drive and the crushing plant with which it is used were designed and manufactured by *Pioneer Engineering Works*, Minneapolis, Minn.



SCHEMATIC of diesel engine-generator drive on a crusher. Photo shows how multi-rib belt drive for approximately 70 hp fits on 6-½-in. stub shaft of engine.

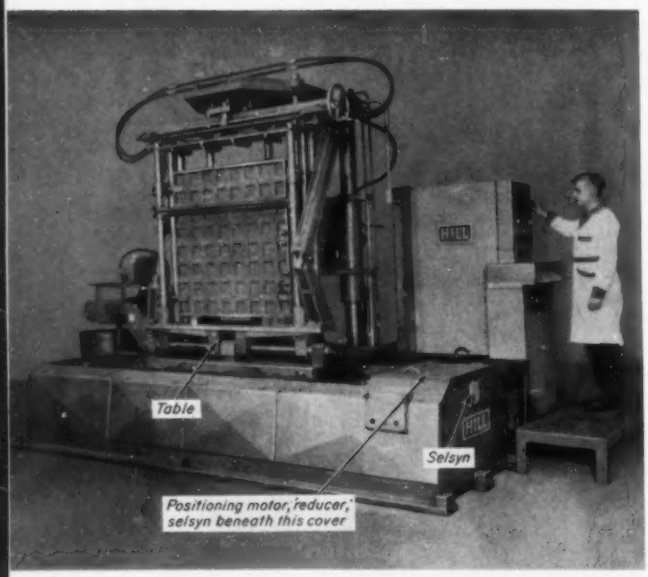


WORM GEAR REDUCER and dc motor drive through ball screw to control table speed and position on machine. Hydraulic cylinder provides most of the force.



SELSYN UNIT is error detecting device. If for any reason correct position cannot be reached, selsyn shuts machine down.

Worm reducer acts as hydraulic control



HORIZONTAL AND VERTICAL TABLES on drilling machine have similar positioning drives. Cylinder speed and position are controlled by a small dc motor, worm reducer, and ball screw.

Worm gear speed reducer acts as a low-cost hydromechanical control for the table of a tape-controlled drilling machine. Most of the force needed to move the table is supplied by a hydraulic cylinder. DC motor drives through the worm-gear reducer at same time cylinder is powering ball-bearing lead screw. Reducer thus only controls distance and speed, performs no power function.

Pressure is continuously applied to the hydraulic cylinder to eliminate backlash and keep table drive stiff. Irreversibility of the reducer-screw drive makes it impossible for the cylinder to move the table unless the motor is running. Thus, dc motor driving through the worm reducer controls both table speed and distance while the cylinder supplies the greater portion of power.

Control of the drive is from punched tape prepared from typewritten instructions. A selsyn is used as the error sensing device and, if correct position is not reached for any reason, the machine is automatically shut down.

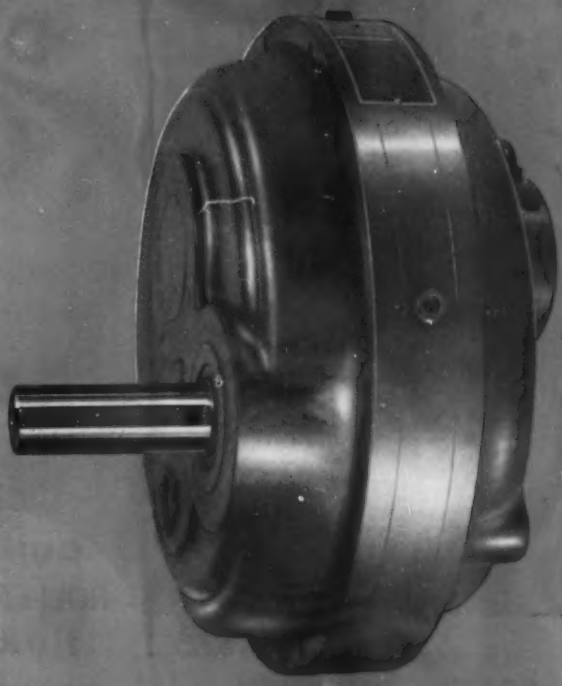
A similar drive is used to raise and lower the 4600-lb spindle head. When operating, both spindle head and table move simultaneously. Travel rate is 84 in. per minute. Total travel of each is 4 ft. Spindle position accuracy is $\pm$ 0.0005 in.

Manufacturer of the machine, *Walter P. Hill, Inc.*, Detroit, Mich.

World's Most Complete Line of Popular Shaft-Mounted Reducers

The Original and Exclusive "Concentric" Shaft-King

The first shaft-mounted reducer on the market . . . proved on over 150,000 installations. Exclusive concentric design permits foolproof torque-arm overload release. Taper-bushed hub makes mounting easy.

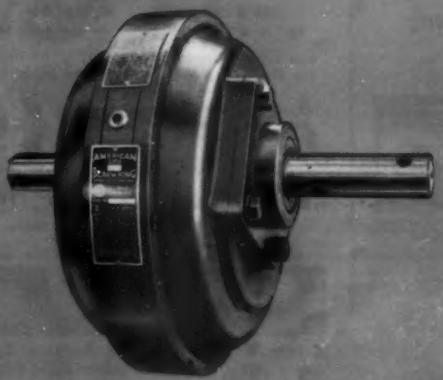


The New "Offset" Shaft-King

Same basic design, engineering and quality that has been proven in the original concentric American Shaft-King, but with input and output hubs offset, permitting easy belt take-up. Taper-bushed hub.

Compact, Easy-to-install Screw-King

The same time-proven design but with extended output hub and dual purpose dust seal. Bolts directly on trough end of screw conveyor eliminating wobble.



Standardize on American Shaft-King Reducers—they're proven, versatile and trouble-free—in 5:1, 13:1 and 20:1 ratios. Call your American Distributor—he has them in stock for you.

POWER TRANSMISSION DIVISION

THE AMERICAN PULLEY COMPANY

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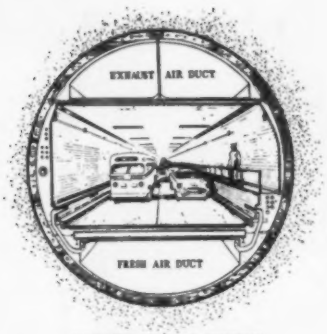


FINISHED TUNNEL SECTION

Two coupled motors give low-cost 4-speed drive

TWO 2-SPEED MOTORS, connected by chain, power ventilating blowers in the third tube of the Lincoln Tunnel. This tube is the latest tunnel connecting Manhattan with New Jersey beneath the Hudson River.

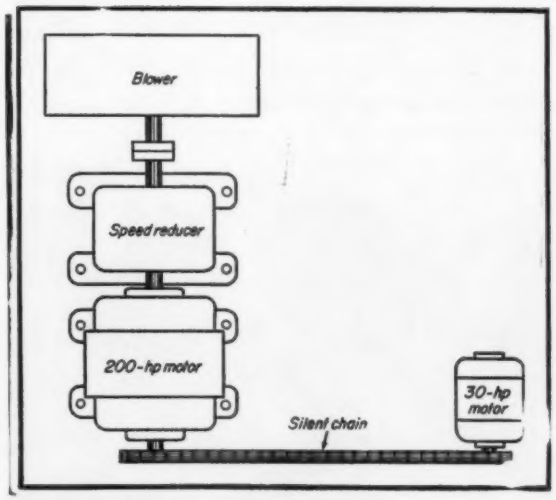
The larger, high-speed, motor has two speeds of 1200 and 900 rpm. The smaller, low-speed, motor, has speeds of 900 and 600 rpm. The smaller motor drives through the larger. Chain drive reduces speed of the smaller motor to 600 and 450 rpm into the larger motor and blower. A reducer between the larger motor and blower has a reduction ratio of 2.67:1 to limit maximum blower speed to 450 rpm.

This drive was selected to replace wound rotor induction motor drives used on older tubes because of increased efficiency and reduced maintenance. The wound-rotor motors had five speeds selected by inserting resistances in the rotor circuit.

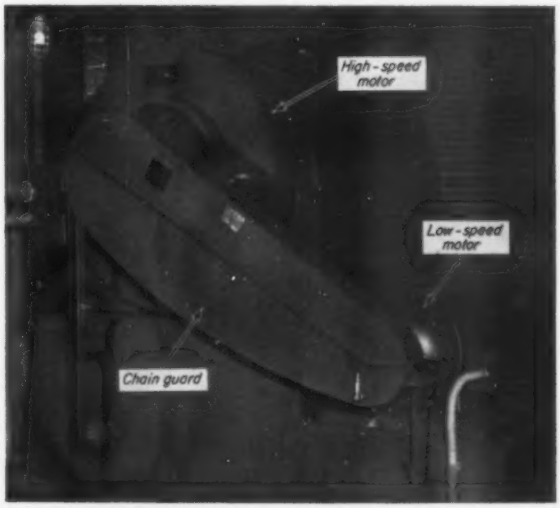
The larger motor is 200 hp, the same as the wound-rotor induction motors used earlier. The small motor is 30 hp. This results in much lower power consumption when operating at slow speeds.

Ventilating air is fed to the 8013-ft-long tunnel through a duct which is almost the complete area of the tube below the roadway. Area of the tube above the roadway serves as the return or exhaust duct. Twenty-four blower units are housed at both ends of the tunnel and will when operated at high speed completely change the air in the tube every 90 seconds.

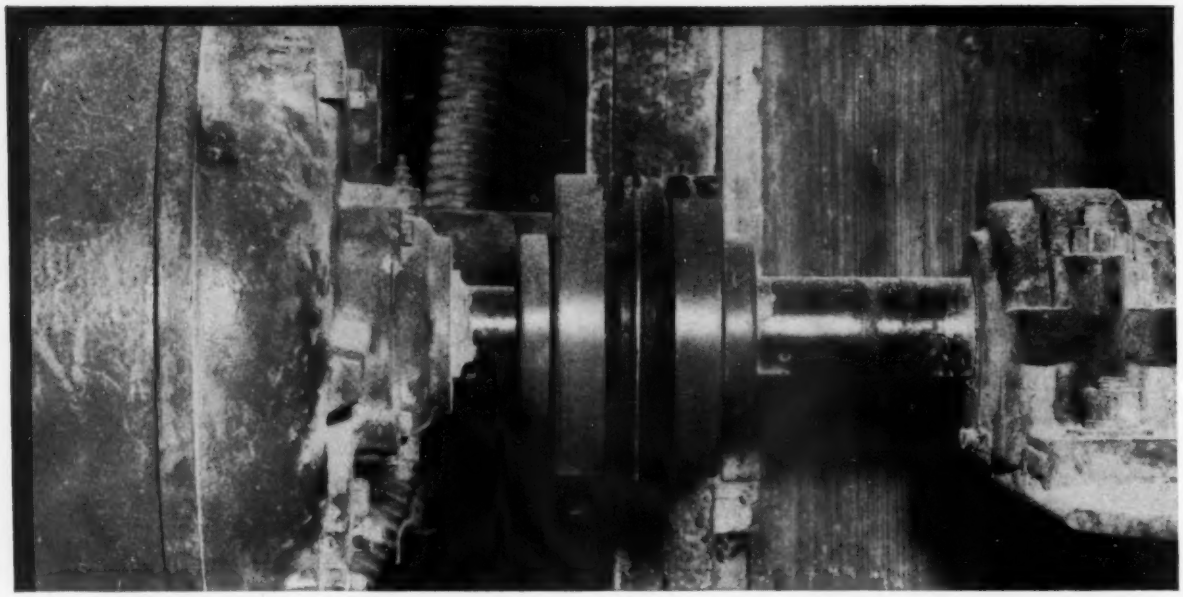
This ventilating drive was designed by engineers of *The Port of New York Authority*.



SCHEMATIC of blower drive system.



FOUR-SPEED FAN DRIVE for the third tube.



"Sure-Flex" Coupling's 4-way flex and unique design . . .

ELIMINATE MOTOR VIBRATION – FAILURE, SOLVE "IMPOSSIBLE" DRIVE PROBLEMS

Extreme vibration and shock, as well as misalignment, posed "impossible-to-solve" coupling problems with this hammer mill drive installation. The motor required rewinding twice in two years. Finally, it was necessary to shut down the mill after less than an hour of operation to let motor and machine bearings cool. A stock "Sure-Flex" Coupling eliminated the vibration . . . absorbed the shock and misalignment . . . permitted coupling of shafts having 9/16-inch diameter differential. Motor and mill bearings now run cool, regardless of operating cycle length.

Unique design and 4-way flexing action enable Wood's "Sure-Flex" Couplings not only to absorb all types and combinations of angular and parallel misalignment and end-float, but from 5 to 15 times more shock and vibration than other leading flexible couplings. There is no metal-to-metal contact, no wear, no need for lubrication or maintenance. "Sure-Flex" Couplings are unaffected by abrasives, dirt or moisture. Operation is noiseless. "Sure-Flex" gives you more for your money than any other flexible coupling. Get all of the facts. Write for Bulletin 10,100A.

SIMPLE, EASY TO INSTALL—There are only four basic parts which lock together without clamps or screws, tightening securely under torque to provide smooth, dependable power transmission.

Wood's

T. B. WOOD'S SONS COMPANY
CHAMBERSBURG, PENNSYLVANIA

ATLANTA • CAMBRIDGE • CHICAGO • CLEVELAND • DALLAS

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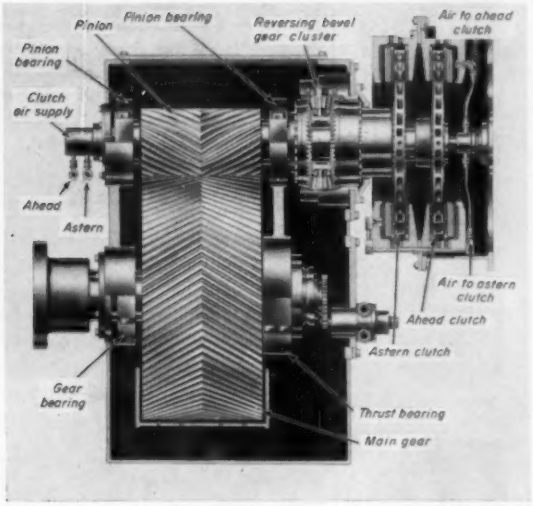
NEW PRODUCTS

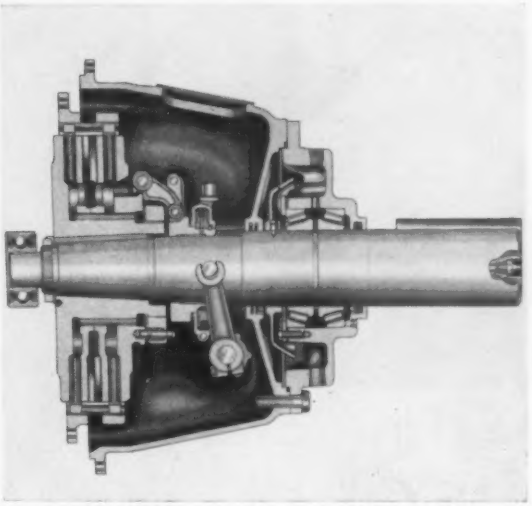


Marine propulsion gear unit

SMR air-actuated, reverse reduction gear units are designed for heavy-duty marine service, where dependability is a basic requirement. They offer continuous, full-power operation and rapid reversing, both at full speed and during cycling. Clutch slip may be controlled for sustained operation at any propeller speed below engine-idling speed, thus permitting more maneuverability. Basic components are a double-helical, single-reduction gear drive; a cluster-type, bevel-gear reversing unit; and a dual air-operated marine clutch with ahead and astern elements in tandem. 8 standard sizes for use with medium to high hp diesel engines.

Farrel-Birmingham Co., Ansonia, Conn.

Circle number 200 on Reader Service Card



High-energy power take-off

New power take-off, model IBF-214P, is built specifically for applications to high-speed engines up to 3380 input rpm where the ability to withstand high-energy heat loads is required. It can operate six months between lubricating. New unit has an exclusive ventilated center plate which prevents minute cracks often caused by uneven thermal stresses from too-heavy starting loads. Plate has two sections with diagonal ribs cast into each. Placed back to back, the ribs cross each other to permit air flow to dissipate excess heat. Clutch action eliminates heavy counterweights, while large tapered roller bearing withstands heavy side loads.

Twin Disc Clutch Co., Racine, Wisc.

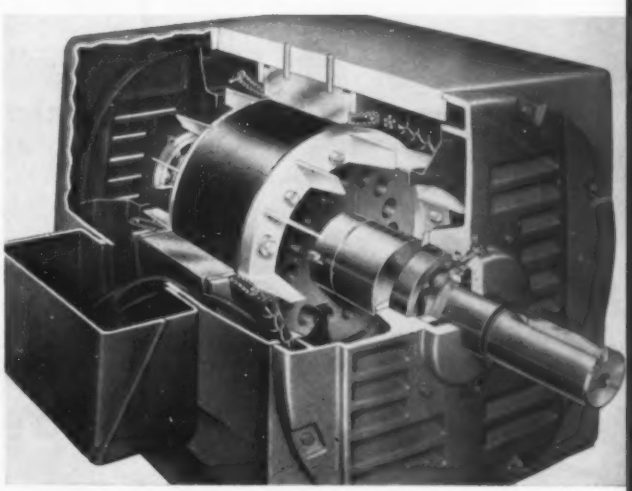
Circle number 201 on Reader Service Card

Ac motors gain versatility with new insulation features

Special design features of company's improved random- and form-wound ac motor line extend open-motor uses and provide necessary modifications for many specific industries. Form-wound models, ranging from 900 to 5,000 hp, have building-block design making it easier to tailor them to user's requirements. Special Poly-seal supported silicone rubber insulating system adds mechanical strength and greater resistance to adverse environments, permitting open motors to replace more costly totally-enclosed styles. Random-wound motors, ranging from 1 to 125 hp, now may for the first time be "moisture-proof by silicone compound sealing, and have significant mechanical improvements, including a labyrinth seal on the shaft to keep water from bearings; cast-iron gasketed conduit boxes; and a waterproof seal where power leads enter frame.

General Electric Co., Schenectady, N. Y.

Circle number 202 on Reader Service Card



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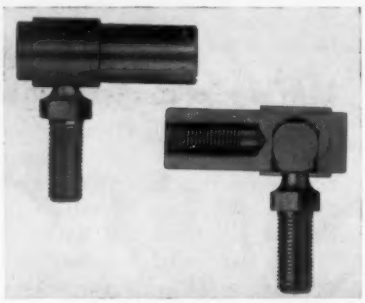
FOR QUICK ACTION . . .

for more information on any new product items on these pages, use Reader Service Card opposite page 64. Just circle number or numbers you want, fill out Card and drop it in the mail. We'll do the rest.

Ball joints

SP series in sizes from 10-32 through ¾-16. Claimed to wear twice as long as standard designs with improved shock resistance from a redesigned ball with shorter, heavier neck. Female part is simplified, eliminating



several parts and reducing cost. Movement is free at any point in minimum conical angle of 30 deg. regardless of defflection plane. Dimensions conform to SAE and other inter-changeable standards.

Superior Ball Joint Corp., Fort Wayne, Ind.

Circle number 203 on reader service card

Daycollan synthetic

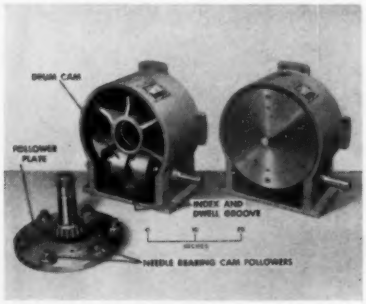
Daycollan is a rubber-like cast urethane synthetic formed from liquid components. Poured and molded, Daycollan sets up and forms a permanent bond with any surface. A thin layer between two metal sleeves makes a drive shaft torsion elastic spring that will transmit full engine torque yet dampen vibration and cushion shock. To use pre-stressed rubber in comparable applications requires much more space and material. Thus smaller drive shaft couplings, smaller drive shaft humps in cars could be achieved.

Dayton Rubber Co., Dayton, Ohio.

Circle number 204 on reader service card

Cam index drives

Give fast, accurate and shock-free indexing of trunnion and dial type index tables on automated machines and special machine tools. Uniform



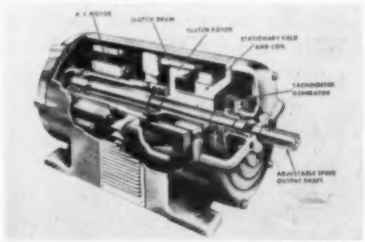
acceleration and deceleration of the table is the basic operation. High torque ratings allow rapid indexing which decreases cycle time and increases machine productivity. For heavy-duty operations, for table sizes from 20 to 100 in. dia. Each standard index drive size can be had for 4, 5, 6, 7, 8, 10, 12 or 16 indexes per table revolution. Smaller drive sizes come with integral gear reducer.

Expert Automation Machine Co., Detroit, Mich.

Circle number 205 on reader service card

Fractional hp drives

Adjusto-Spede models with stationary field coils eliminate slip rings, brushes, commutator. Control features for inching, precise speed adjustment and control, with other control features



optional. Several lines for various hp ranges, mounting positions, etc. Models ACM 903, 904 offer 20 ratings from ½ hp at 8000 rpm to 7½ hp at 3400 rpm. Eddy-current or Dyna-TorQ friction-type brakes.

Eaton Mfg. Co., Dynamatic Div., Kenosha, Wis.

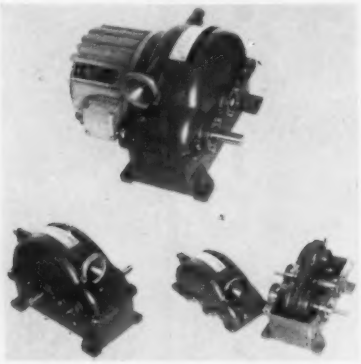
Circle number 206 on reader service card

Continued on next page

CONTINUED *from preceding page*

Variable-speed transmission

Built around newly developed TV-belt providing a 3 to 1 ratio with basically constant hp. Timing belt pulley provides the belt with constant driving speed. By adjustment of 2 idler pulleys the toothed portion of



the belt can wrap over the timing pulley and the V-portion over the automatic variable-speed pulley. When plate assembly is rotated away from the variable-speed pulley, TV-belt is drawn into the faces, separating them and allowing the belt to operate at a smaller pitch diameter. 3 to 1 ratio at 1.5 hp, 1750 rpm input speed.

Western Mfg. Co., Detroit, Mich.

Circle number 207 on reader service card

Master breadboard kits

Precision kits, in precision Class 1, 2 and 3 tolerances, are stock items. Over 2000 different precision items contained, such as precision gears,

speed reducers, differential, limit stop assemblies, etc., adaptable to all mechanical and electronic applications. Choice of kit for 1/8, 3/16, 1/4 in. shaft dia.

PIC Design Corp., East Rockaway, N. Y.

Circle number 208 on reader service card

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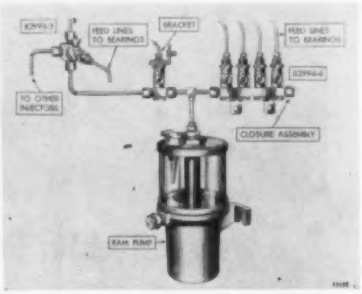
Injector lube system

For automatic lubrication of production machinery. Micro-Measure system pre-measures and injects fluid lubricants to millionths of an ounce in automatic cycles as often as once a minute. Automatically controlled, air-operated pump supplies lubricant to injectors placed where needed. System keeps constant, uniform film on



all bearing surfaces with no over-supplying or dripping. Successfully used now in textile, metalworking, packaging and other industries.

Lincoln Engineering Co., Industrial Div., St. Louis, Mo.

Circle number 209 on reader service card

Combination belting

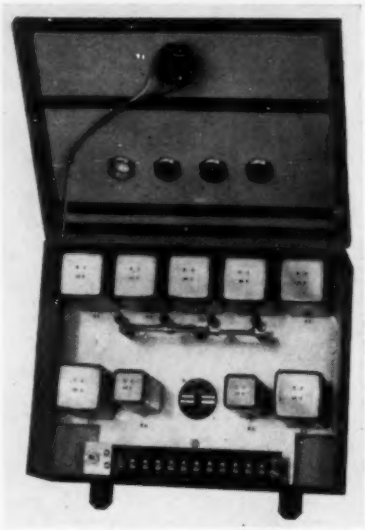
Combination timing belt and V-belt permits transmission of power with both sides of the belt. Dual belting is not new, but this type lets you use a positive drive, non-slip timing belt that needs no lubrication. At the recent Design Show in Philadelphia, sample belt was shown in single serpentine drive to power all car accessories. T-V belts are bonded together in integral construction and the V-side is notched to make it more flexible. Can operate to 16,000 fpm on fixed centers without take-up adjustment. Speed ratios up to 30:1 are possible with pulley diameters as small as ½ in. at 10,000 rpm.

U. S. Rubber Co., New York, N. Y.

Circle number 210 on reader service card

Automatic engine control

Synchro-Start full controls are enclosed in a steel, dust-proof casing and feature overload breakers and plug-in relays. Breakers eliminate



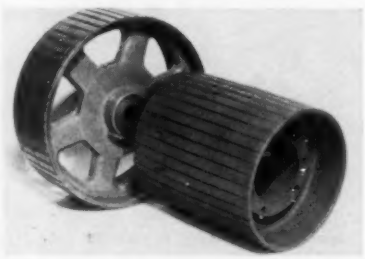
need for fuses, and the relays make field maintenance easier. When cabinet cover is closed, relays are automatically locked in their sockets by cushion pressure. Engines can be started or stopped from remote pilot devices such as pressure switches, float switches, power failure relays.

Synchro-Start Products, Inc., Skokie, Ill.

Circle number 211 on reader service card

Corrugated pulleys

Corrugated, cross-grooved surface gives pulleys added efficiency by preventing air being trapped between belt and pulley surfaces. Line is specially good for short center distance

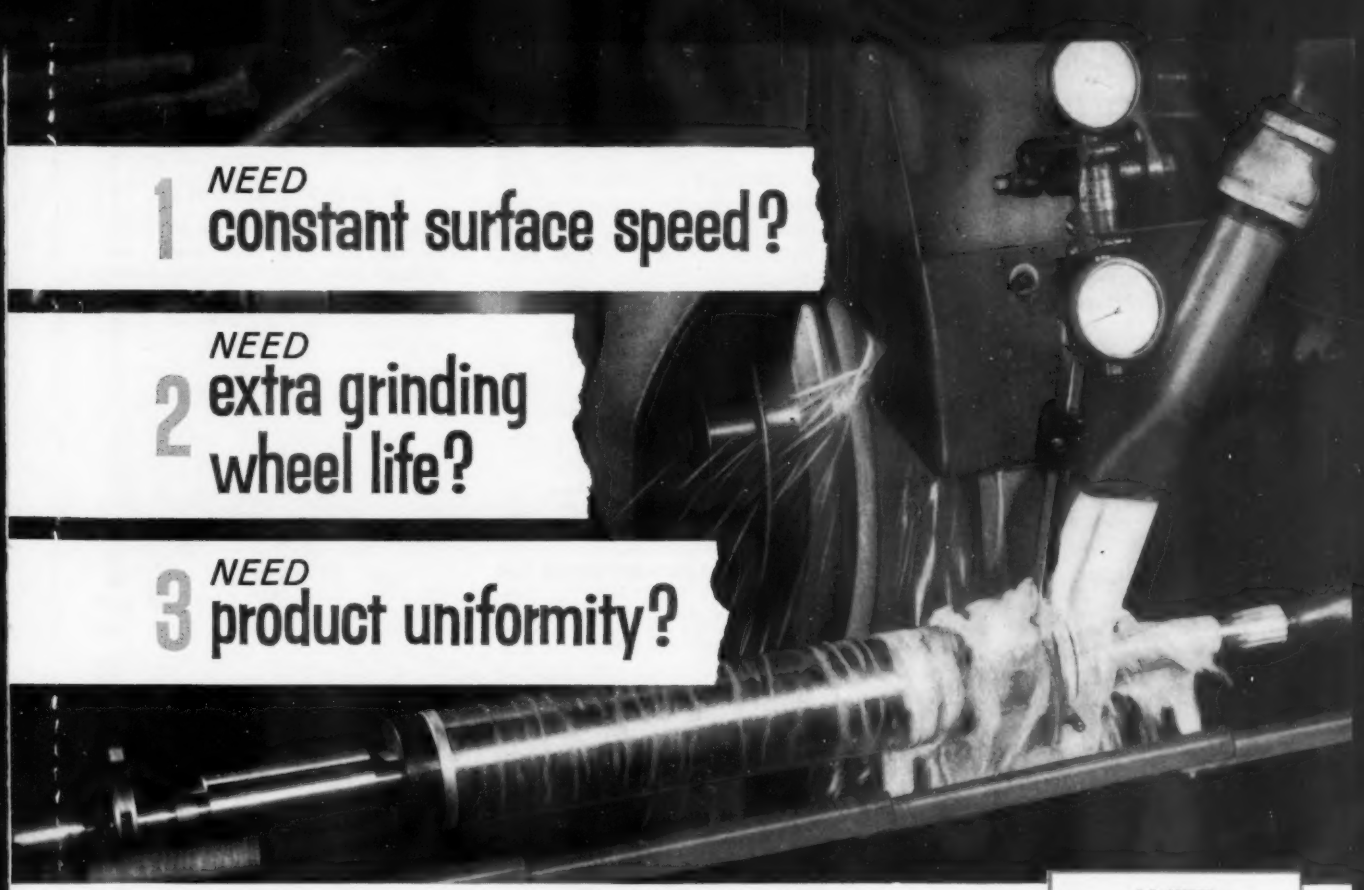


and intermittent load applications. 3½ to 16 in. diameters, various widths to 12 in. for standard QD hubs.

Republic Engineering & Mfg. Co., St. Paul, Minn.

Circle number 212 on reader service card

Continued on page 38



1 *NEED* **constant surface speed?**

2 *NEED* **extra grinding wheel life?**

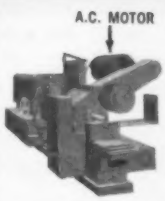
3 *NEED* **product uniformity?**

you get all three with...

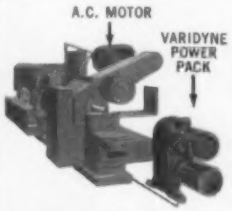
U.S. VARIDYNE GRINDER CONTROL

It is now possible to adjust grinding wheel speed on a cylindrical grinder *automatically*. The U.S. VARIDYNE GRINDER CONTROL provides controlled frequency of A.C. electric power and can, thus, convert your standard, A.C. grinding wheel motor into a variable speed drive. This results in: (1) CONSTANT SURFACE SPEED—or peripheral speed which is accomplished by varying the wheel speed according to wheel diameter. This eliminates downtime for pulley changes and provides optimum cutting speeds. (2) EXTRA GRINDING WHEEL LIFE—infinite adjustment and correct operating speeds mean fewer wheel dresses, less wear, and better use of wheel at extreme diameters. (3) PRODUCT UNIFORMITY—automatic control of wheel-to-work speed insures uniform finish regardless of wheel wear. Because of adjustable wheel speed feature, you can handle more materials with the same grinder and often without wheel changes. VARIDYNE makes your grinder more versatile. In addition, there is no danger of overspeed through loss of D.C. motor field as only A.C. motors are used.

VARIDYNE GRINDER CONTROL is another example of how Industry is using standard A.C. motors for variable speeds through the use of VARIDYNE. Your U.S. Motors representative will be glad to show you how VARIDYNE will solve your production problems. Call or write today.



BEFORE INSTALLING VARIDYNE, grinding speed changed as wheel circumference wore down.



WITH VARIDYNE, wheel wear is compensated by increasing rpm, maintaining constant grinding speed.

U.S. ELECTRICAL MOTORS INC.

P.O. BOX 2058, LOS ANGELES 54, CALIFORNIA
OR MILFORD, CONNECTICUT

U.S. MAJOR MOTOR LINES INCLUDE:
1. Vertical Solid & Hollowshaft, 2. Varidrive, 3. Totally-Enclosed, 4. Uniclosed, 5. Syncrogear. Also, many other special motors.

FREE ILLUSTRATED BROCHURES ...for complete information send for FREE *Varidyne Bulletin No. F-1910 and Controlled Speed System Bulletin No. F-1952.*

For more information circle No. 27 on Reader Service Card

CONTINUED *from preceding page*

Miniature clutch-brake units

New magnetic clutch and brake line features unusually high torque ratings with outstanding reliability and long life under full torque loads. Intended

for use in servo and control systems, analogue computers and precision instrumentation, line includes nine models in five frame sizes, torque ratings from 6-in.-oz to 224 in.-oz with power consumption from 2.5 to 5 watts. O.D. from .9 to 2 in.

Dynamic Instrument Corp., Westbury, N. Y.

Circle number 213 on reader service card

Lightweight accelerometer

Model 2224 accelerometer is designed for application where size and weight of the instrument are critical. Model is ½ in. high, weighs only 9 grams and provides 5 pk-mv/pk-g sensitivity

with a first resonant frequency of 30KC. Frequency response is 2 to 6000 cps.

Endevco Corp., Pasadena, Calif.

Circle number 214 on reader service card

Subfractional gearmotors

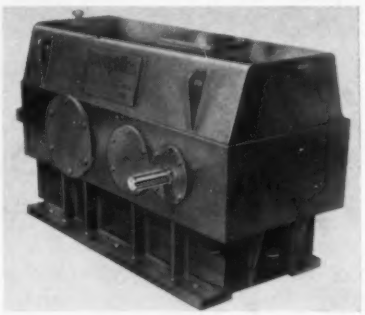
Stock designs of subfractional hp induction and synchronous geared motors offer 17 gear ratios, each with output speeds from 1 to 300 rpm. Corresponding full load torques for the induction motor are from 1.2 lb-in. to 15 lb-in., and torques for synchronous motor from 0.5 to 15 lb-in. High starting torque, 100 to 120 percent of full load torque for induction motors and 350 percent of "pull-into-synchronous" torque for synchronous motors. For 115 v, 60 cycles a-c.

Merkle-Korff Gear Co., Chicago, Ill.

Circle number 215 on reader service card

Tough gear drive units

Maxi-Power drives specially designed for primary metals industries. High-strength fabricated steel housing added to basic heavy-duty helical gear drive creates unit capable of withstanding severe impact. Single,



double, triple reductions. Nine shaft assemblies. Ratios from 208 to 1 up to 360 to 1. Capacities to 1550 hp.

Foote Bros. Gear & Machine Corp., Chicago, Ill.

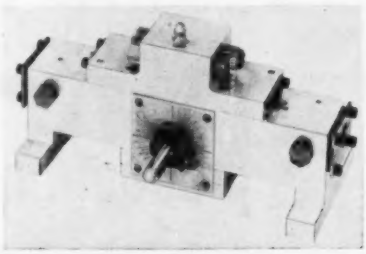
Circle number 216 on reader service card

Hydraulic power unit

Self-contained rotary torque power unit has versatile built-in controls. For low-cost, controlled hydraulic power in many machine tool, aircraft, missile and commercial applications. Operating at a power input range from 50 to 1,000 psi, the unit converts hydraulic pressure into reciprocating rotary motion easily regulated according to need. Power output at 1,000 psi hydraulic pressure will give 500 in.-lb working torque over a range of rotation from 5 to 360 deg. Built-in speed adjustments allow com-

FOR QUICK ACTION . . .

for more information on any new product items on these pages, use Reader Service Card opposite page 64. Just circle number or numbers you want, fill out Card and drop it in the mail. We'll do the rest.



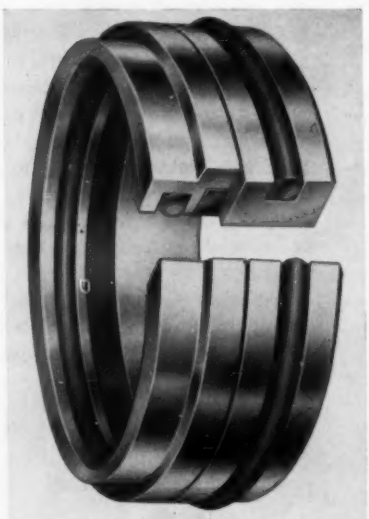
plete control of rotary shaft speed in either or both directions. Self- or solenoid-actuated.

Cleveland Pneumatic Industries, Inc., Skokie, Ill.

Circle number 217 on reader service card

Magnetic seal

Replaces mechanical seals by providing a positive, permanent seal without use of springs or set screws. Unfailing magnetic force provides



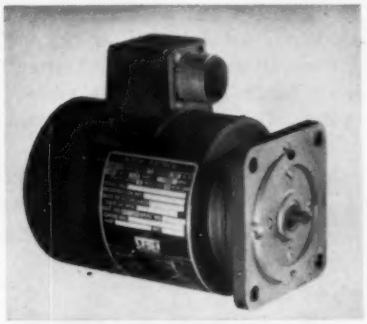
constant, unvarying pressure to keep the sealing faces in contact during all operational cycles.

A. W. Chesterton Co., Everett, Mass.

Circle number 218 on reader service card

Cargo hoist motor

Compact a-c motor for flyaway applications. Model 693 is reversible and features a quick stopping magnetic brake and torque limiting clutch.



Nominal force at drive shaft is 5 in-lbs at 7200 rpm. Starting torque is 10 in.-lb min. For 200 v, three-phase, 400-cycle systems.

U. S. Industries, Inc., Western Design Div., Santa Barbara, Calif.

Circle number 219 on reader service card

Push-type broaches

Minute Man production type keyway broaches of high-speed steel can be used with hydraulic or hand-operated arbor presses to broach gears. Back of the broach is ground to fit radius of the bore so the body supports itself in the hole without guiding or bushing. For keyway widths from 1/16 to 1/4 in., 1/16 in. increments.

Du Mont Corp., Greenfield, Mass.

Circle number 220 on reader service card

Precision gears

Solid hub type precision gears are available in stainless steel and anodized aluminum in standard diametral pitches 48 through 200 with consecutive tooth selection range from 20 through 120 teeth. Made to AGMA

Precision Class 1 and 2 tolerances. 0.120, 1/8, 3/16 and 1/4 in. bores.

U. S. Gear Corp., Wakefield, Mass.

Circle number 221 on reader service card

Continued on next page

CONTINUED *from preceding page*

Integral brake motor

High torque-to-size ratio with type FC brake motors for start-stop operations in drives and positioning systems. Motor can be wound for 115 or 200 v a-c, 60 or 400 cycles in hysteresis-synchronous or induction types. Intermittent torques to 12 oz-in.

Electro-mechanical brake has coil wound for any desired voltage to 100 v d-c, with diode in circuit giving d-c power. Brake holding force is 10-oz-in., engagement time is 40 to 50 milliseconds.

Globe Industries, Inc., Dayton, Ohio.

Circle number 222 on reader service card

Magnetic drive

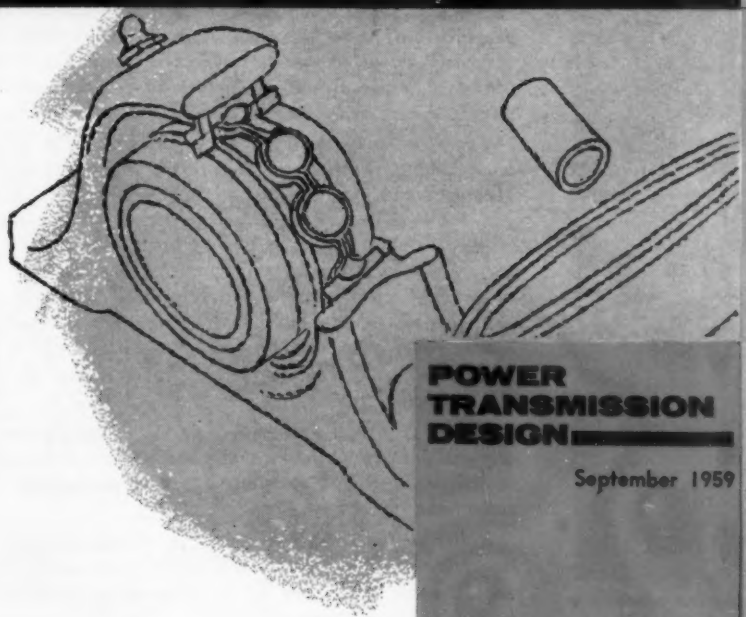
Tormag is frictionless, high efficiency drive for 1 to 15 hp range. Two basic parts: cylindrical magnetic rotor containing permanent magnets, and bimetallic rotor which is copper-faced steel perforated with steel rivets. Rotors are mounted with air-gap between. Bimetallic rotor always rotates at motor speed, and serves as the driving component. Torque is induced through eddy currents in magnetic rotor. Driving and driven rotors are never in contact. Efficiency, motor protection, wide speed adaptability, dynamic braking are achieved. 7 models, for 1 to 15 input hp at 1750 rpm, give 3 to 45 ft-lb torques.

Whitney Chain Co., Hartford, Conn.

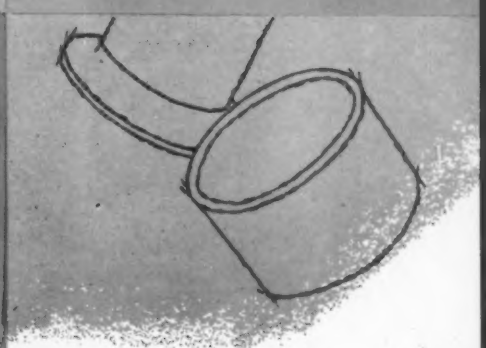
Circle number 223 on reader service card

BEARINGS

DESIGN/APPLICATION

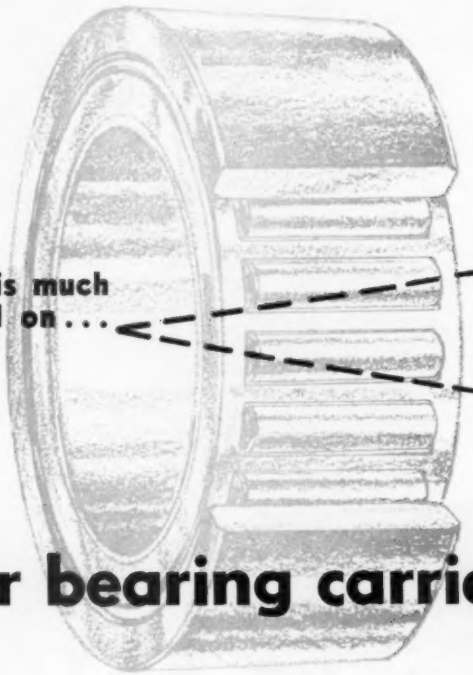


REGULAR MONTHLY SECTION OF IDEAS AND DEVELOPMENTS



POWER TRANSMISSION DESIGN

September 1959



Since a roller has this much surface to roll on . . .

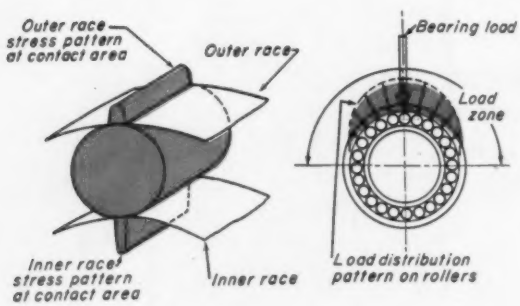
A roller bearing carries

Large rolling area makes the difference

A roller rolls on a long thin rectangular area. Large contact area, therefore, is the principle reason for high load carrying capacity of roller bearings.

The stress pattern within each roller is analogous to that of a paved roadway. The edges of the roadway are weakest even though they are just as thick as inboard areas. Weakness exists because the edges are unsupported outward, unlike the areas inboard.

To offset this, rollers are usually relieved at the extremities to reduce stress build-up. This lets the load be carried more homogeneously throughout.

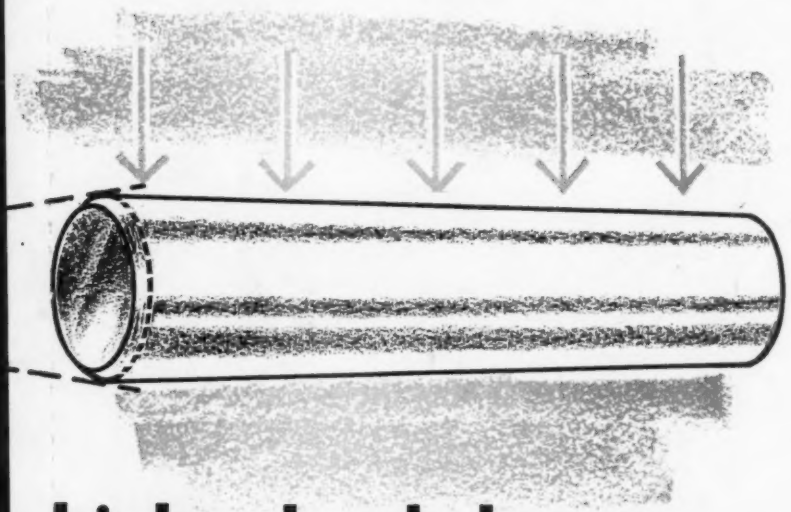


Load transmitted to rollers is spread over a larger area on the outer ring than on the inner ring as shown in the drawing. The inner ring, therefore, absorbs higher unit loading and is the more critical member of the two. This factor is usually considered during construction by manufacturers. Higher press fits help make inner races more integral with rotating shafts to help distribute load more evenly.

Every roller in a bearing passes through a load zone during operation as shown in the second drawing. Highest loading takes place at the mean center of the concentrated area of load application. Beyond this point on either side, load progressively diminishes to zero. The load zone may range from zero to 120 deg on either side of the contact area depending on the load and internal clearance. Load on the most heavily loaded roller in a cylindrical roller bearing can be approximated as $5/N$ times bearing load, where N is the number of rollers.

Rollers with excessive edge relief carry load abnormally and heat up. Different manufacturers use different techniques to assure greatest degree of perfection in roller manufacture.

Roller shapes vary. There are cylindrical, spherical, tapered, conical and others and different variations of each. Needle rollers are $\frac{1}{4}$ in. diameter or less and have high length/diameter ratio.



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higher loads longer

Rolling the load gives longer, more dependable life

Factors you should consider in determining bearing size are load, speed and anticipated life. Only slight measurable wear will occur during useful life if a bearing is kept clean and well-lubricated. When failure does occur, it is usually caused by metal fatigue.

Fatigue is gradual deterioration caused by repeated stress. Relationship between load and number of stress repetitions is approximately

$$\text{Life} \propto \frac{1}{(\text{load})^3} \quad \ldots\ldots(1)$$

That is, if load on one bearing is twice load on an identical one, life of the first should be approximately one-eighth that of the second. Different manufacturers use different modifications of this formula.

Life is a measure of the number of stress repetitions before failure. If speed is increased, failure will take place sooner than at slower speed when cycles are used up at a slower rate.

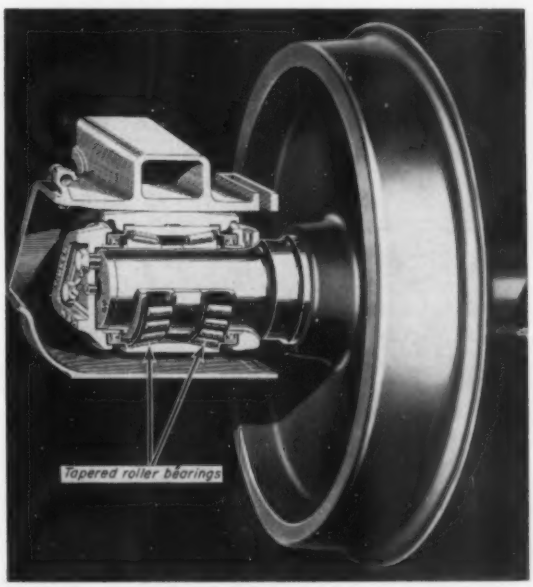
The relationship between life and speed is

$$\text{Life} \propto \frac{1}{\text{speed}} \quad \ldots\ldots(2)$$

The relationship between speed and load is

$$\text{Speed} \propto \frac{1}{(\text{load})^3} \quad \ldots\ldots(3)$$

Thus, if you follow basic selection rules, of which the above are three, you will get long, dependable life from a roller bearing.

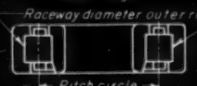


SEALED TAPERED roller bearings assure long dependable life for railroad car wheels.

Standard AFBMA roller bearing types

Cylindrical, outer ring with internal roll retaining snap ring grooves

Cylindrical, single row, separable inner ring

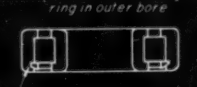


Cylindrical, single row, outer ring and roll assembly

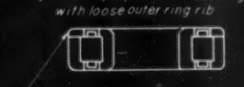
Cylindrical, with outer ring snap ring groove

Cylindrical, with outer ring locating snap ring

Cylindrical, with roll retaining snap ring in outer bore

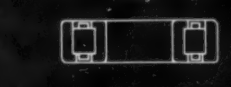


Cylindrical, separable outer ring with loose outer ring rib



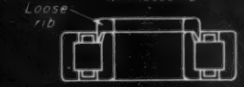
Cylindrical, separable inner ring, loose inner ring rib

Cylindrical, separable outer ring



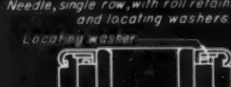
Cylindrical, inner ring and roll assembly

Cylindrical, inner ring with loose rib

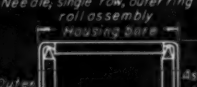


Self-aligning, single row, internal self-aligning inner ring raceway spherical angular contact

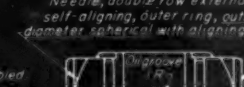
Needle, single row, with roll retaining and locating washers



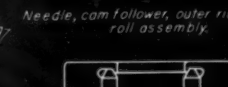
Needle, single row, outer ring and roll assembly



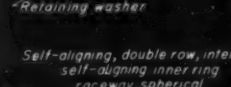
Needle, double row external self-aligning, outer ring, outside diameter spherical with aligning ring



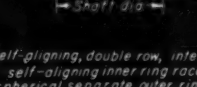
Needle, cam follower, outer ring and roll assembly



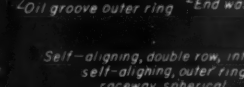
Self-aligning, double row, internal self-aligning inner ring raceway spherical



Self-aligning, double row, internal self-aligning inner ring raceway spherical separate outer rings

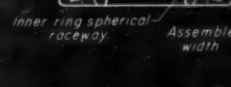


Self-aligning, double row, internal self-aligning, outer ring raceway spherical



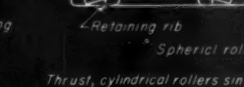
Tapered single row

Tapered, single row cageless

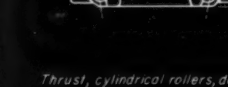


Tapered, single row, locating flange on outer ring outside diameter, with cage

Thrust, cylindrical rollers single direction, flat seats, outside weather shed

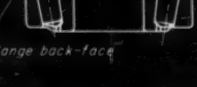


Thrust, cylindrical rollers, double direction, flat seats, one roller cage assembly, inner and outer locating sleeves



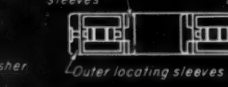
Thrust, cylindrical roller, single direction flat seats

Thrust, cylindrical rollers, double direction, flat seats, one center plate, one inside locating collar two roller cage assemblies



Thrust, cylindrical rollers double direction, two self-aligning seats and washers, one center plate flat seat, one inside locating collar two roller cage assemblies

Thrust, cylindrical rollers, single direction, one flat, one self-aligning seat with aligning washer



Tapered, double row, double raceway cup, separate cones, non-adjustable with cage

Tapered double row, double raceway cup, separate cones, adjustable by cone spacer, cageless

Tapered, double-row, double raceway cone, separate cups, adjustable with cage

Tapered double row, double raceway cup, separate cones, adjustable with cage

Tapered, thrust with cage

Tapered, thrust with outside retaining band and cage

Know Your Roller Bearing Code?

YOU SHOULD. It's the AFBMA series of letters and digits with which you can specify any type or size roller bearing (or ball) regardless of manufacturer.

The code shows how to identify and specify bearings by type, principal dimensions—bore, OD and width—installation instructions, shields, seals, separators, lubricants and other special instructions, all with letters and digits.

Examples

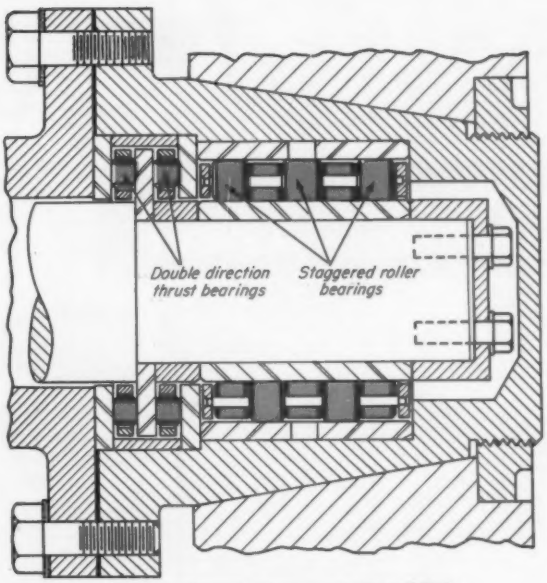
16JTB1625 means a journal roller bearing, inch dimension, solid roller assembly, planished outer ring—1 in. bore, 1 in. width and 1-9/16 in. OD.

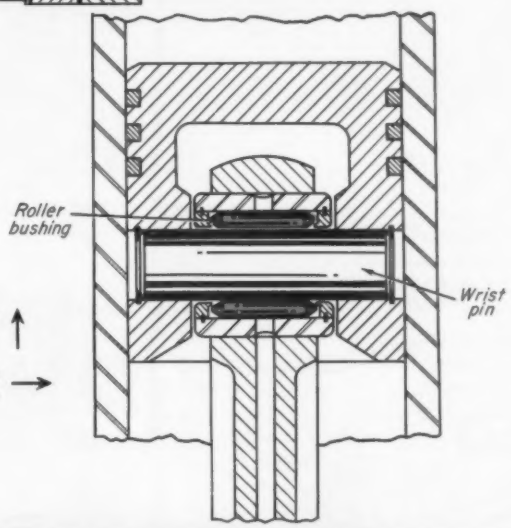
60MTE34130 means a journal roller bearing, bore and OD in mm, width in sixteenths of an inch, solid roller assembly, inner and outer rings, 60 mm bore, 2-1/8 in. width and 130 mm OD.

8NAA1616 means a needle roller bearing with one-piece channel shaped outer raceway, single row, outer ring retainment of rollers, no inner ring, 1/2 in. bore, 1 in. width and 1 in. OD.

125L625 means a loose roller of spherical end design with 1/8 in. dia and 5/8 in. length with standard tolerances.

3125LBH2000 means a loose roller with ball end design of 5/16 in. dia, special .006 in. length tolerance and 2 in. length.

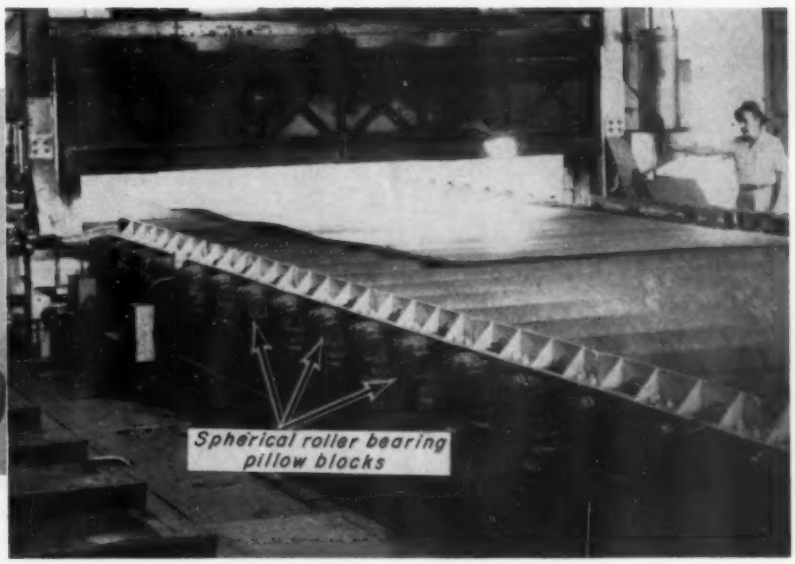


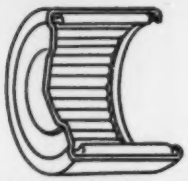


STAGGERED ROLLER BEARING distributes shock loads more uniformly in rock crushing machine. ↑

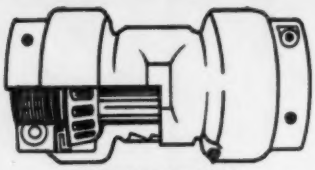
ROLLER BUSHING provides minimum torque loss on piston of gasoline engine, requires little radial space. →

HEAVY ROLLERS on heat treating furnace are supported by spherical roller bearing pillow blocks with adapter mounts.

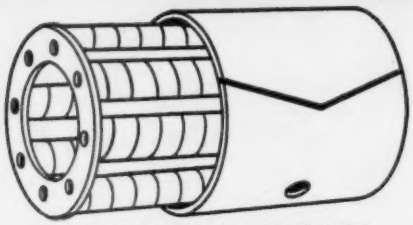




ONE-ENDED NEEDLE BEARING

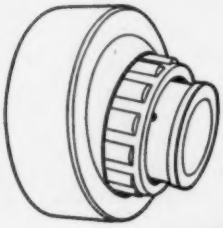


HANGER BEARING



WOUND ROLLER, SPLIT OUTER RACE

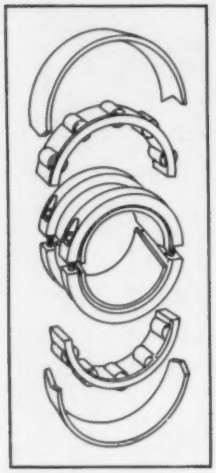
There are special bearings for almost any application



FOR RADIAL MISALIGNMENT

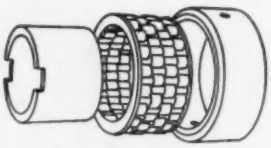
HEAVY-DUTY PILLOW BLOCK

LARGE THRUST BEARING

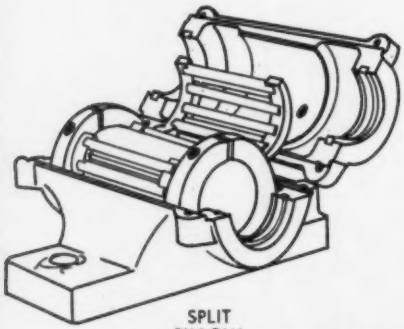


COMPLETELY SPLIT BEARING

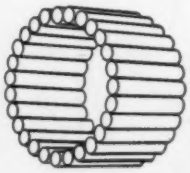
COMBINATION RADIAL AND THRUST PILLOW BLOCK



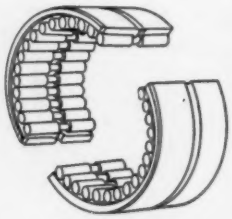
STAGGERED ROLLERS



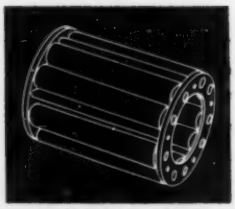
SPLIT PILLOW BLOCK



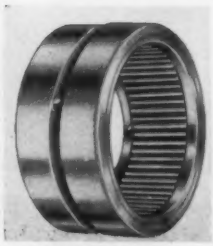
NEEDLE ROLLERS ONLY



SPLIT BEARING

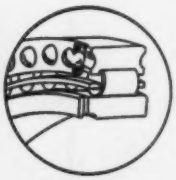


BEARING WITHOUT RACES

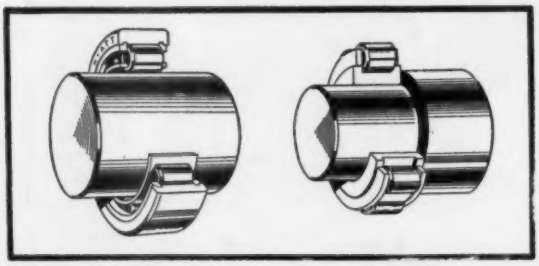


ROLLER BUSHING

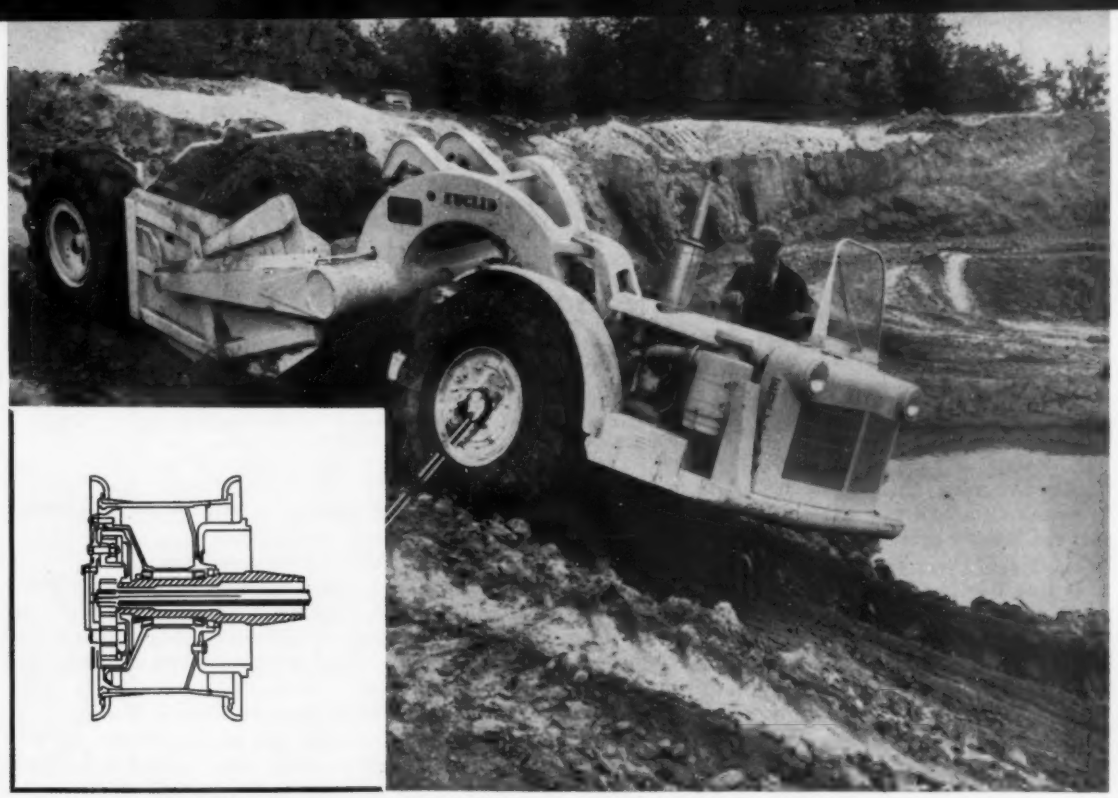
SPECIAL SPLIT BEARING



COMBINATION BALL & ROLLER



NO INNER RACE NO OUTER RACE



DIRT AND MUD are sealed out of tapered wheel bearings that carry varying loads.

Fixed Vs Floating Bearings

A shaft that supports a gear, pulley or other type of rotary element should be free of undesirable radial or axial movement. Rotation is usually the only desirable movement.

The standard approach is to use two bearings sets. One adjacent to the rotating wheel is usually fixed. This means that the inner ring is fastened axially to the shaft and the outer ring is held axially in the housing. The remaining set is fastened axially to the shaft but floats in the housing.

Floating bearings prevent cramping and overloading. If bearings are mounted with minimum tolerances and maximum shaft tolerances they preload. Likewise, where temperature of the shaft becomes higher than temperature of the housing, resulting shaft expansion overloads the bearing.

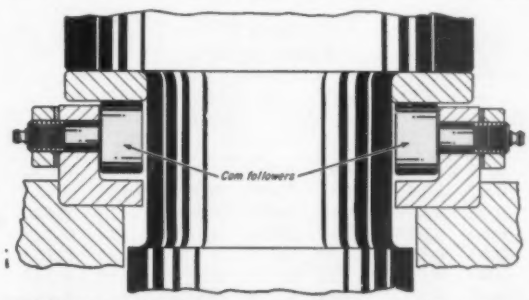
Steel expands .000006 inches per inch per degree F so a shaft 24 in. long, operating 100 F higher than the housing, expands .0144 inches. Without floating, a bearing would preload .0144 inches.

Thrust load is always carried by the fixed bearing. Under certain conditions, the fixed bearing may be opposite the rotating element instead of adjacent to it. If so, the adjacent bearing floats.

To assure proper movement, the rotating ring should have an interference fit with the revolving part and the stationary ring a sliding fit with its journal. Electric motors, gear assemblies and axles usually have a revolving shaft with interference fits. Their housing fits are generally loose enough to allow bearings to move axially when assembled and to float when shaft length increases due to temperature, or other reasons.

Where wheels revolve around stationary axles, such as automobile front wheels, loose pulleys and others, the outer ring is usually specified with an interference fit in the housing and the inner ring slides into position during assembly.

If interference fit specified on a shaft that rotates is not sufficient, load on the inner ring compresses the shaft within and leaves space at the bottom of the ring. If the shaft seat were one inch with a looseness after compression of .001 inch, the two surfaces would



SEVERAL CAM followers mounted in a split ring act as the thrust bearing for main shaft of a large press.

act like gears. That is, as the shaft rotates one revolution, the inner ring also moves but not one revolution. In other words, the ring creeps backward as slippage occurs. This is what generates heat and causes fretting corrosion which results in wear and noise.

The amount of interference fit is dependent on shaft size and bearing load. Tables are available from manufacturers and are categorized as to light, normal and heavy loads.

How to compute dynamic load ratings for radial bearings

Life of a roller bearing is defined as the number of revolutions (or hours at some given constant speed) that the bearing runs before first evidence of fatigue in material of either ring or of any rolling elements.

Rating life of a group of identical bearings is defined as the number of revolutions (or hours at some given constant speed) that 90 percent of a group will complete or exceed before first evidence of fatigue.

Basic load rating is that constant stationary radial load which a group of apparently identical bearings with stationary outer ring can endure for a rating life of one million revolutions of the inner ring. In single-row angular-contact bearings, basic load rating relates to radial component of load which causes purely radial displacement of the rings in relation to each other.

Load ratings, if given for specific speeds, are based on a rating life of 500 hours.

Equivalent load is defined as that constant stationary radial load which, if applied to a bearing with rotating inner ring and stationary outer ring, would give the same life as that under actual conditions of load and rotation.

The magnitude of the basic load rating C for radial roller bearings is

$$C = f_c\,(il_{eff}\cos\alpha)^{7/9} Z^{3/4} D^{29/27} \quad \text{.....(1)}$$

Table 1
Values of f_c/f

$D\ \cos\alpha$*	f_c/f					
	Columns					
d_m	j	h	b	a	g	k
0.01	0.061	0.069	0.077	0.083	0.089	0.095
0.02	0.072	0.081	0.090	0.097	0.104	0.111
0.03	0.078	0.088	0.099	0.106	0.113	0.120
0.04	0.083	0.094	0.105	0.113	0.120	0.128
0.05	0.087	0.099	0.110	0.118	0.126	0.134
0.06	0.091	0.102	0.114	0.123	0.131	0.139
0.07	0.093	0.105	0.118	0.126	0.135	0.144
0.08	0.096	0.108	0.121	0.130	0.138	0.147
0.09	0.098	0.110	0.123	0.132	0.141	0.150
0.10	0.099	0.112	0.125	0.134	0.143	0.152
0.12	0.102	0.115	0.128	0.138	0.147	0.156
0.14	0.103	0.117	0.130	0.140	0.149	0.159
0.16	0.104	0.118	0.131	0.141	0.151	0.161
0.18	0.105	0.118	0.132	0.142	0.151	0.161
0.20	0.105	0.118	0.132	0.142	0.151	0.161
0.22	0.104	0.117	0.131	0.141	0.150	0.160
0.24	0.103	0.116	0.130	0.140	0.149	0.159
0.26	0.102	0.115	0.128	0.138	0.147	0.156
0.28	0.100	0.113	0.126	0.136	0.145	0.154
0.30	0.099	0.112	0.124	0.134	0.143	0.152

*d_m = mean pitch diameter of roller set.

where

- D = roller diameter (mean diameter of tapered rollers)
- Z = number of rollers per row
- f_c = factor which depends on the units used; exact geometrical shape of load-carrying surfaces of rollers and rings; accuracy to which various bearing parts are made; and material
- i = number of rows of rollers in bearing
- l_{eff} = effective length of contact between one roller and that ring where contact is the shortest (over-all roller length minus roller chamfers, or minus grinding undercuts) ....
- α = angle of contact

Values of f_c are obtained by multiplying f_c/f by factor f as shown in Table 1.

Roller bearings vary considerably in design and execution. Small differences in relative shape of contacting surfaces may account for distinct differences in load-carrying capacity. It is therefore not possible to cover all design variations adequately.

Generally, a bearing of good quality and made by a reputable manufacturer must be expected to have a capacity lower than that obtained by using a value f_c/f taken from Table 1 if, under load, local stress concentration is present in some part of the roller contact.

This may be the case if the rollers are not accurately guided. Stress concentration is also present at the end of a line contact or in the center of a point contact even though the rollers are well guided.

On the other hand, capacity may be expected to be higher than that obtained by using a value of f_c/f taken from Column *a* in Table 1 if even stress distribution over the whole roller length is automatically assured. For no bearing type or execution will factors f_c/f be higher than those taken from Column *k* in Table 1.

This general evalution of f_c/f is applied to some specific bearing designs listed in Table 2. The last column indicates from which column in Table 1 the value of f_c/f should be selected for the respective bearing execution.

Approximate magnitude of the rating life L is found from

$$L = \left(\frac{C}{P}\right)^{10/3} \text{ million revolutions} \quad \text{.....(2)}$$

where

P = equivalent load

Table 2
Selection of f_c/f for Various Bearing Designs

Item	Type of Bearing	f_c/f Selected from the following column in Table 3
1	Cylindrical roller bearings with line contact* between rollers and both rings, rollers not accurately guided.	j
2	Cylindrical roller bearings with line contact* between rollers and both rings, rollers accurately guided by machined cage or by uninterrupted guide surfaces at each end of rollers, both surfaces associated with one of bearing rings.	h
3	Cylindrical roller bearings with line contact* between rollers and one ring and point contact† with other, rollers accurately guided by machined cage or by uninterrupted guide surfaces at each end of rollers, both surfaces associated with one of bearing rings.	b
4	Cylindrical roller bearings with modified line contact‡ between rollers and both rings, rollers guided by cage or by two snap rings, or one snap ring and one integral rib.	b
5	Cylindrical roller bearings with modified line contact‡ between rollers and both rings, rollers accurately guided by uninterrupted surfaces at each end of rollers, both surfaces associated with one of bearing rings. (When rollers are longer than 2.3 times diameter, use column b in Table 1).	k
6	Tapered roller bearings with line contact* between rollers and both rings, rollers accurately guided by one integral rib.	h
7	Tapered roller bearings with line contact* between rollers and one ring and point contact† with other, rollers accurately guided by one integral rib.	b
8	Tapered roller bearings with modified line contact‡ between rollers and both rings, rollers accurately guided by one integral rib.	g

*Term "line contact" refers to rollers and raceways so formed that under no load and when in good alignment they contact along full length of basic form.

†The term "point contact" refers to rollers and raceways so formed that under no load and when in good alignment they contact at point located approximately at middle of rollers, and that under bearing load of about one quarter of basic load rating C contact ellipse at most heavily loaded roller is formed whose length is equal to length of their basic form.

‡The term "modified line contact" refers to such departure from basic form of rollers or ring raceways or both towards their ends that under bearing load of about one half of basic load rating C, material stress at ends of contact of most heavily loaded roller with ring is approximately same as in rest of this contact.

When values for f_c/f listed in Table 1 are applied to non-self-aligning bearings with line contact or modified line contact at both rings, C values refer to mountings so designed and executed that uniform load distribution over roller length is assured. If misalignment is present, a reduction in C should be made before estimating rating life.

Magnitude of equivalent load P is found for tapered and self-aligning radial roller bearings of conventional types, under combined constant radial and constant thrust loads from

$$P = XVF_r + YF_a \quad \text{.....(3)}$$

where

F_a = thrust load
F_r = radial load
V = rotation factors =
1.0 for inner ring rotating in relation to load
1.2 for inner ring stationary in relation to load
X = radial factor
Y = thrust factor

Values of X and Y are given in Table 3.

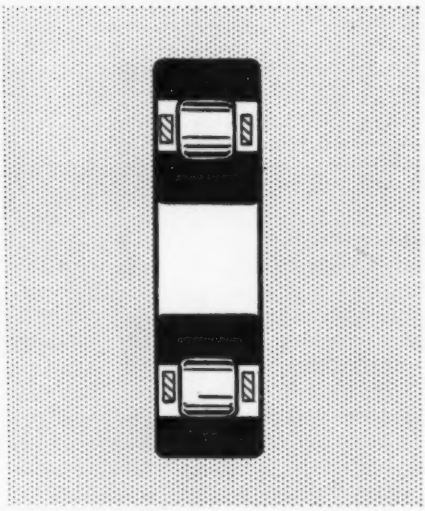
Factor V, due to lack of sufficient experimental evidence, is used as a matter of precaution.

Table 3
Factors X and Y

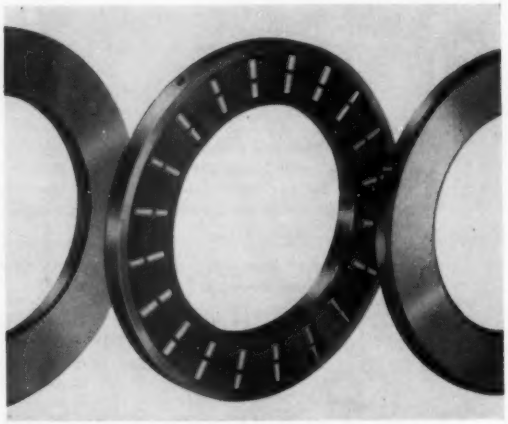
Bearing Type	$\frac{F_a}{VF_r} \leq e$		$\frac{F_a}{VF_r} > e$		e
	X	Y	X	Y	
Self-Aligning and Tapered Roller Bearings (α does not equal 0 degrees)*	Single-Row Bearings				
	1	0	0.4	0.4 cot α	1.5 tan α
	Double-Row Bearings†				
	1	0.45 cot α	0.67	0.67 cot α	1.5 tan α

* For $\alpha = 0$ degrees: $F_a = 0$ and $X = 1$.
† Double-row bearings are presumed to be symmetrical.

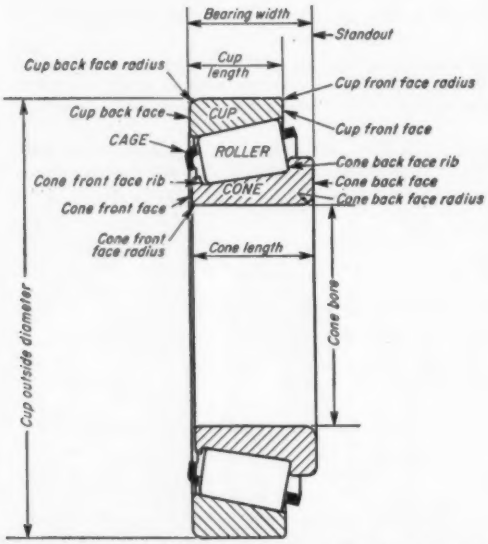
Here are some important roller bearing differences



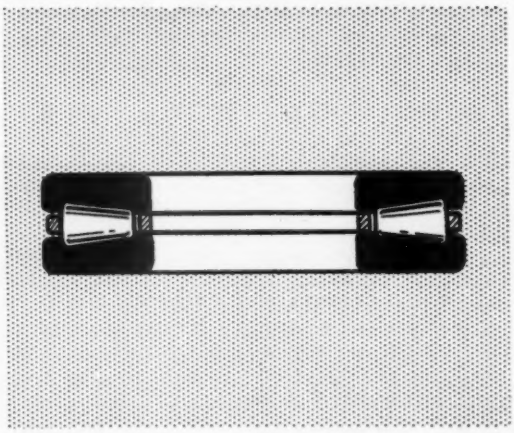
RADIAL BEARING carries radial loads only.



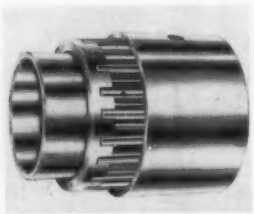
THRUST BEARING carries axial loads only.



COMBINATION BEARING carries radial and axial loads; shown is tapered roller bearing.

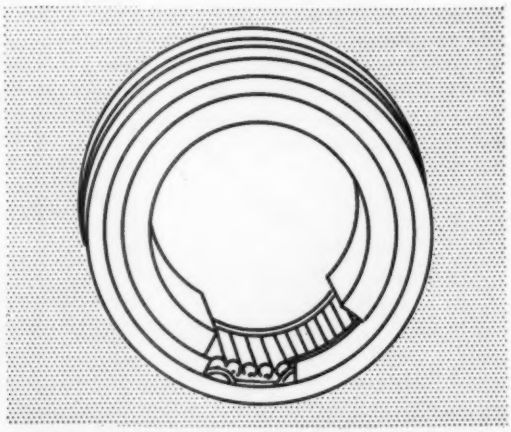


CONICAL THRUST bearing provides some radial location.

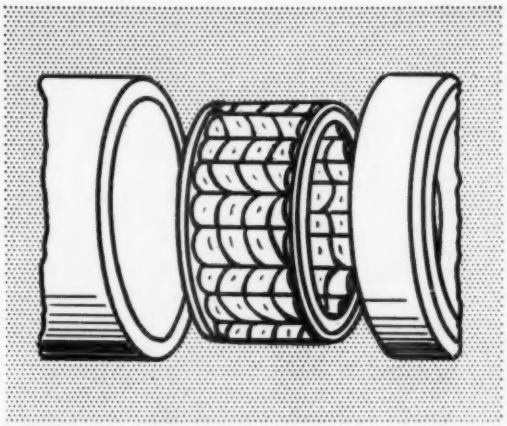


JOURNAL BEARING for soft shafts and housings.

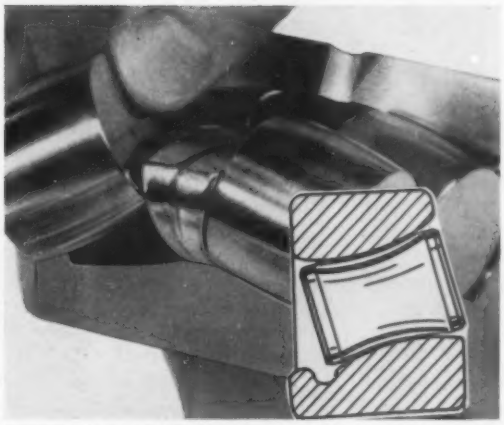
"X" ROLLER BEARING carries combination loads.



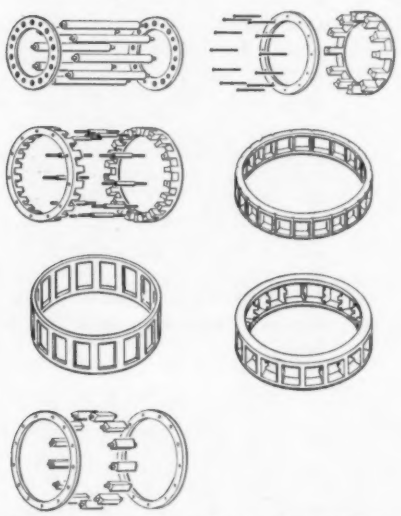
ROLLER BUSHING is compact and uses small amount of radial space.



WOUND ROLLER bearing has hollow rollers of helically-wound alloy strip, has high shock resistance.

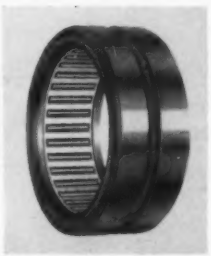


SPHERICAL BEARINGS are self-aligning; there are barrel, hour-glass, crowned, concave and convex.

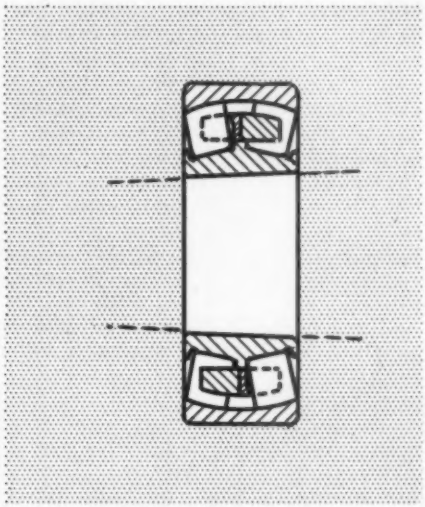


HERE ARE a few roller bearing retainer types.

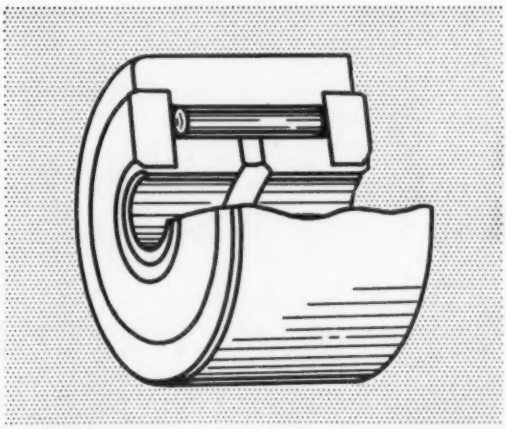
◄ **L to R: trunnioned; drilled pocket; pocketed end ring; separable broached; stamped steel; non-separable broached; formed bar.**



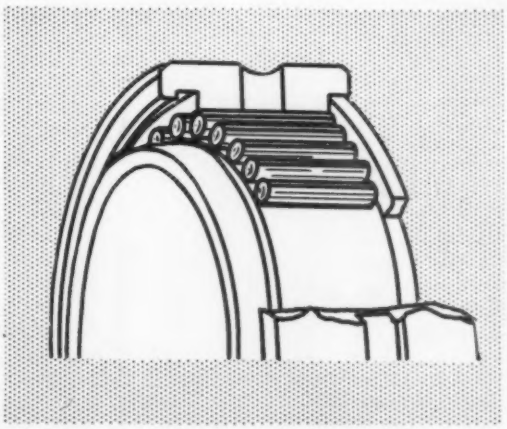
NEEDLE BEARING has long slim rollers.



TAPERED BORE bearing is distinct from tapered roller bearing.



CAM YOKE rollers guide along cam surfaces.



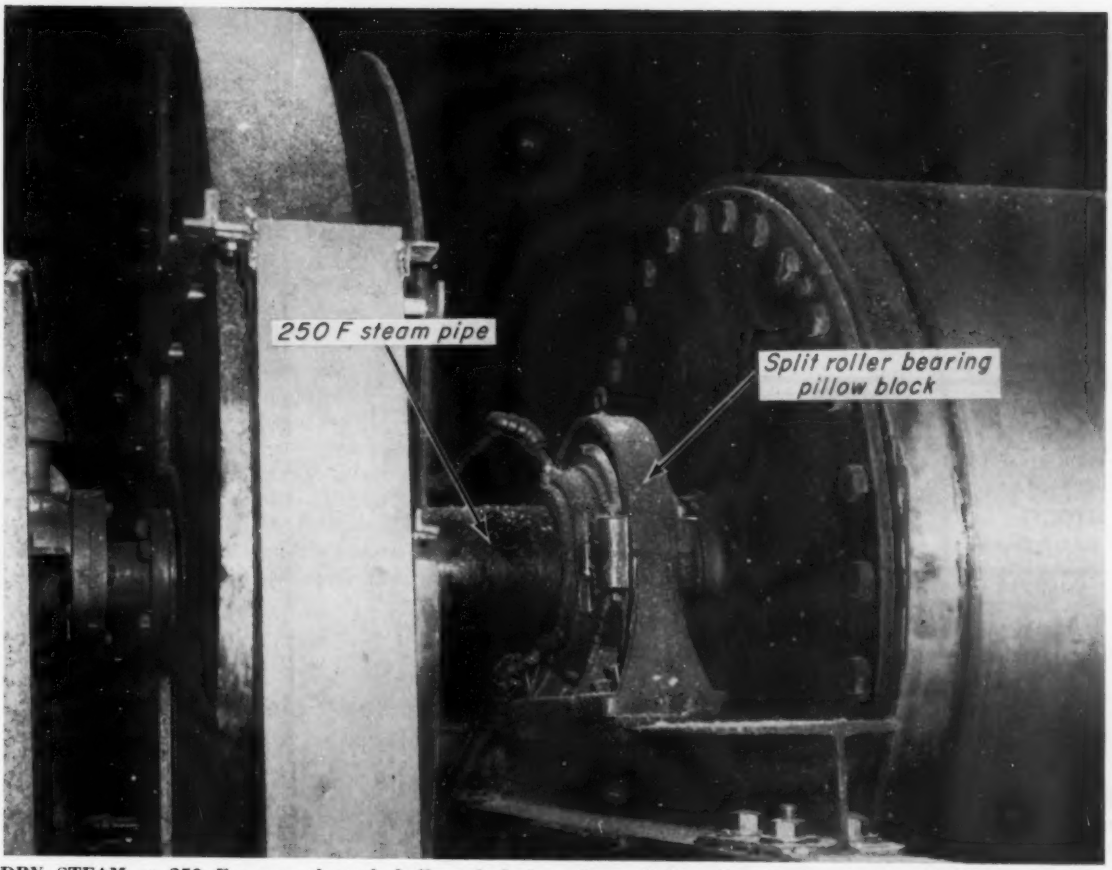
FULL-TYPE bearing has no cage or separator.

Glossary of descriptive terms

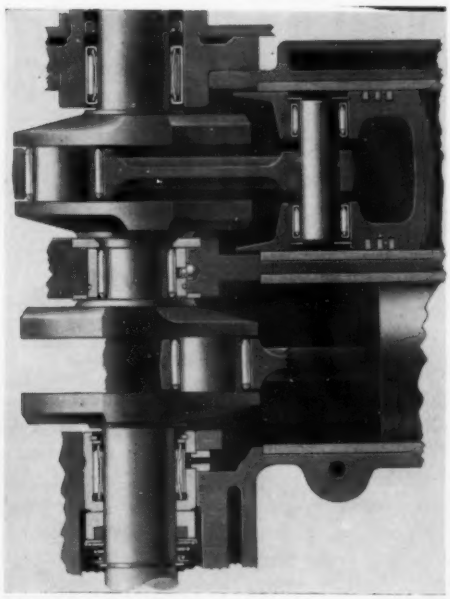
Self-aligning	*Either inner or outer raceway spherical*
Raceway	*Track on either ring on which rolling elements travel*
Thrust bearing	*Axial loading only*
Cone	*Tapered bearing inner ring*
Cone rib, back face	*Annular ribs on tapered bearing inner rings to retain assembly and receive roller end thrust*
Contact seal	*Rubbing contact seal*
Cup	*Tapered bearing outer ring*
Cylindrical roller	*Axis of rollers parallel to bearing axis*
Crowned roller	*Cylindrical roller very slightly tapered or beveled at ends*
Filling-slot	*Notch in raceway shoulder to permit assembly of maximum number of rolling elements*
Full type bearing	*Full complement of rolling elements, cageless*
Inch dimension bearing	*Having boundary dimensions made to integral or fractional inch figures, rather than metric*
Journal bearing	*Cylindrical bearing usually made to fractional dimensions, has relatively high roller length-diameter ratio, has separable outer ring*
Metric bearing	*Bearing with bore, OD and width dimensions in millimeters*
Needle bearing	*Bearing with rolling elements very long in relation to diameter*
Radial clearance	*Total movement of unclamped ring diametrically when specified load is reversed*
RBEC 1, RBEC 5	*Roller Bearing Engineer's Committee of AFBMA standards of bearing precision*
Roller assembly	*Rollers and cage*
Spherical roller	*OD contour conforms to curve of sphere*
Square roller	*Diameter and length equal*
Tapered roller	*One end smaller than other; frustum of a cone*
Wound (spiral) roller	*Roller made by winding strip in helical form*
Separator, cage, retainer	*Device which partly surrounds rolling elements and travels with them to space the elements in proper relationship*
Solid roller	*Roller having no hole at its axis*
Stand out	*Distance back face of cone extends from cup in tapered bearing*

Roller Bearing Manufacturers

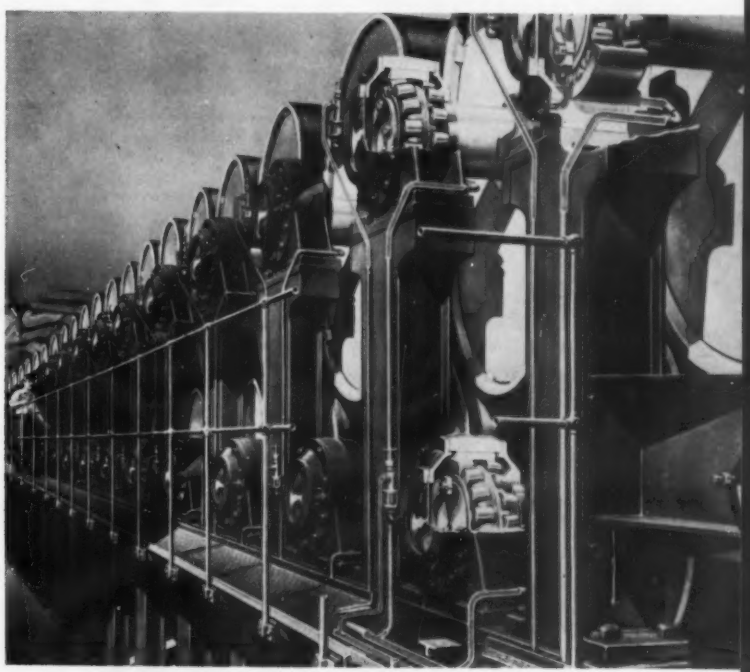
Acorn Bearing Company
Aetna Ball & Roller Bearing Co.
American Ball Bearing Company
American Roller Bearing Company
Ann Arbor Bearing & Mfg. Co.
Ball and Roller Bearing Company
Ball & Roller Bearing Division
Link-Belt Company
Bantam Bearings Division
The Torrington Company
Bearings Company of America
Div. Federal-Mogul-Bower
Bearings, Inc.
Bearings Manufacturing Company
Bearing Service Company
Berliss Bearing Company
Bower Roller Bearing Div., Federal-
Mogul-Bower Bearings, Inc.
Bremen Bearings, Inc.
Consolidated Bearings Co., Inc.
deGroh Bearing Company
The Fafnir Bearing Company
Gwilliam Company
Hyatt Bearings Division
General Motors Corporation
Industrial Tectonics, Inc.
International Harvester Company
Joy Ball Bearing Corporation
Kaydon Engineering Corporation
L & S Bearing Company
Marlin-Rockwell Corporation
McGill Manufacturing Company
Messinger Bearings, Inc.
New Hampshire Ball Bearings, Inc.
Norma-Hoffmann Bearings Corp.
Orange Roller Bearing Co., Inc.
Roller Bearing Co. of America
Rollway Bearing Company, Inc.
Royersford Foundry & Machine
Company, Inc.
Shafer Bearing Division
Chain Belt Company
SKF Industries, Inc.
Smith Bearing Company, Inc.
Split Ballbearing Division
Miniature Precision Bearings,
Inc.
Stephens-Adamson Mfg. Co.
The Timken Roller Bearing Co.
The Torrington Company
Trumbull Bearing & Eng. Co.
Tyson Bearing Company
Div. of SKF Industries, Inc.
Zubler Bearing Corporation



DRY STEAM at 250 F passes through hollow shaft into drum. Split roller bearing is assembled around shaft.



DRAWN CUP roller bearings are used on crankshaft of outboard engine and full-type needle bearings on wrist pins. Needle rollers without cages or separators are used on crank throws. Fractured outer race bearing is used at crankshaft center for lifetime of engine.



SPHERICAL ROLLER BEARINGS on large paper-making machine have grooves in OD for continuous oil flow.

BOOKS

Engineering Vibrations

By Lydik S. Jacobsen and Robert S. Ayre. Published by McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N. Y. Price: $10.00.

Analyses of technical vibrations of linear and non-linear systems, with emphasis on the transient state of motion with the stationary state considered as a special case. This approach thus centers on various aspects of current interest in shock problems. A beginning knowledge of differential equations is assumed. The authors demonstrate the setting-up and solution of equations of motion for a number of vibrating systems, with non-linear relationships introduced in many cases. 564 pages.

Lubrication Science and Technology

Volume 1, number 2 of the Transactions of the American Society of Lubrication Engineers. Edited by John Boyd. Published by the ASLE, and available from Pergamon Press, 122 East 55th Street, New York 22, N. Y. Price: $10.00.

Abstracts of Society papers presented at meetings and in association journals cover variety of lubrication subjects, most of which should be of interest to any student in the field. Written by leaders in their respective areas of research, they make a suitably technical sourcebook. 16 papers, concisely written, each with reference lists; all well-illustrated diagramatically and pictorially. 346 pages.

Electric Motors & Generators Illustrated

Published by the Philosophical Library, 15 East 40th Street, New York 16, N. Y. Price: $12.00.

An up-to-date practical guide to the generation and application of electricity. Aimed primarily at those outside the electrical engineering field, it is also a useful "refresher" survey for those professionally interested. Avoiding difficult theory and mathematics as far as possible, it describes all types of a-c and d-c motors and generators: design, construction, installation, operation, testing and maintenance. There is an appendix explaining the fundamentals of electrical theory for those whose knowledge needs brushing up. Written by a team of experts from industry and academic areas. Profusely illustrated, admirably indexed. 384 pages.

LITERATURE on drives and components

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Rubber-cushioned sleeve bearing and dihedral gear types giving full hp transmission. Important economies in original equipment or replacement.

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Snow-Nabstedt Gear Corp., Hamden, Conn.

Circle number 13 on reader service card

Couplings

Complete line all-metal flexible couplings for diesel engines and marine, industrial and heavy industry applications: Catalog 51A, 32 pages.

Thomas Flexible Coupling Co., Warren, Pa.

Circle number 25 on reader service card

Versatile clutch

Magneclutch prevents wear, gives torque transmission independent of speed by varying magnetized coil current. Bulletin 6000A.

FOR QUICK ACTION . . .
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Vickers, Inc., Electric Products Div., St. Louis, Mo.

Circle number 29 on reader service card

Universal joint

Special brake mounting attaches brake disc or drum to the transmission flange, independent of the bolts that attach joints to the flange. Entire unit may thus be perfectly balanced.

Mechanics Universal Joint Div., Borg-Warner Corp., Rockford, Ill.

Circle number 20 on reader service card

Armature drive

Spline drive armatures for use with company's electric clutches and brakes for rugged, low-cost drives in high-cycle applications. Bulletin P-68.

Warner Electric Brake & Clutch Co., Beloit, Wisc.

Circle number 30 on reader service card

Spring-loaded pulleys

Give you variable-speed drives with variable or fixed centers, automatic or manual. Ratios to 4:1 on ⅛ to 2 hp drives.

Maurey Mfg. Corp., Chicago, Ill.

Circle number 18 on reader service card

Added-hp V-belts

Company's complete line of E-C cord, Hy-TV, and Compass-V-Steel belts now available with extra hp-carrying capacities, for example, 40 percent more with Plus-Rated cord belts.

Goodyear, Industrial Products Div., Akron, Ohio.

Circle number 15 on reader service card

Parallel shaft drives

Maxi-Power line helical gear drives. Single, double, triple reductions; standard ratios from 2.08 to 1 to 360 to 1; nine shaft arrangements, capacities to 1550 hp.

Foote Bros. Gear and Machine Corp., Chicago, Ill.

Circle number 14 on reader service card

Gear motors and reducers

Ritespeed models, fractional to 80 hp., ratios to 82:1. Floor, ceiling, wall or vertical mounting styles.

Crofts U.S.A., Inc., Chicago, Ill.

Circle number 7 on reader service card

Universal joints

Bulletin 527 describes full line of joints in 13 standard sizes with hubs, bored or solid, from .375 to 4.000 in.

American Stock Gear Div., Perfection Gear Co., Harvey, Ill.

Circle number 22 on reader service card

Multiple V-belts

DA 358 belts give more hp in given area, at less cost, and with fewer belts, smaller and lighter sheaves and shorter center distances.

Durkee-Atwood Co., Minneapolis, Minn.

Circle number 11 on reader service card

Miniature chain, sprockets

Accurate motion transfer without complicated gearing. Unlimited center to center selection for servo, gyro, electronic assemblies, etc. Catalog gives details.

Sierra Engineering Co., Sierra Madre, Calif.

Circle number 24 on reader service card

Shaft motion indicator

Roto-Guard shows drop in speed or stopping of machinery, gives protection to slow-moving machinery. Bulletin RG-16.

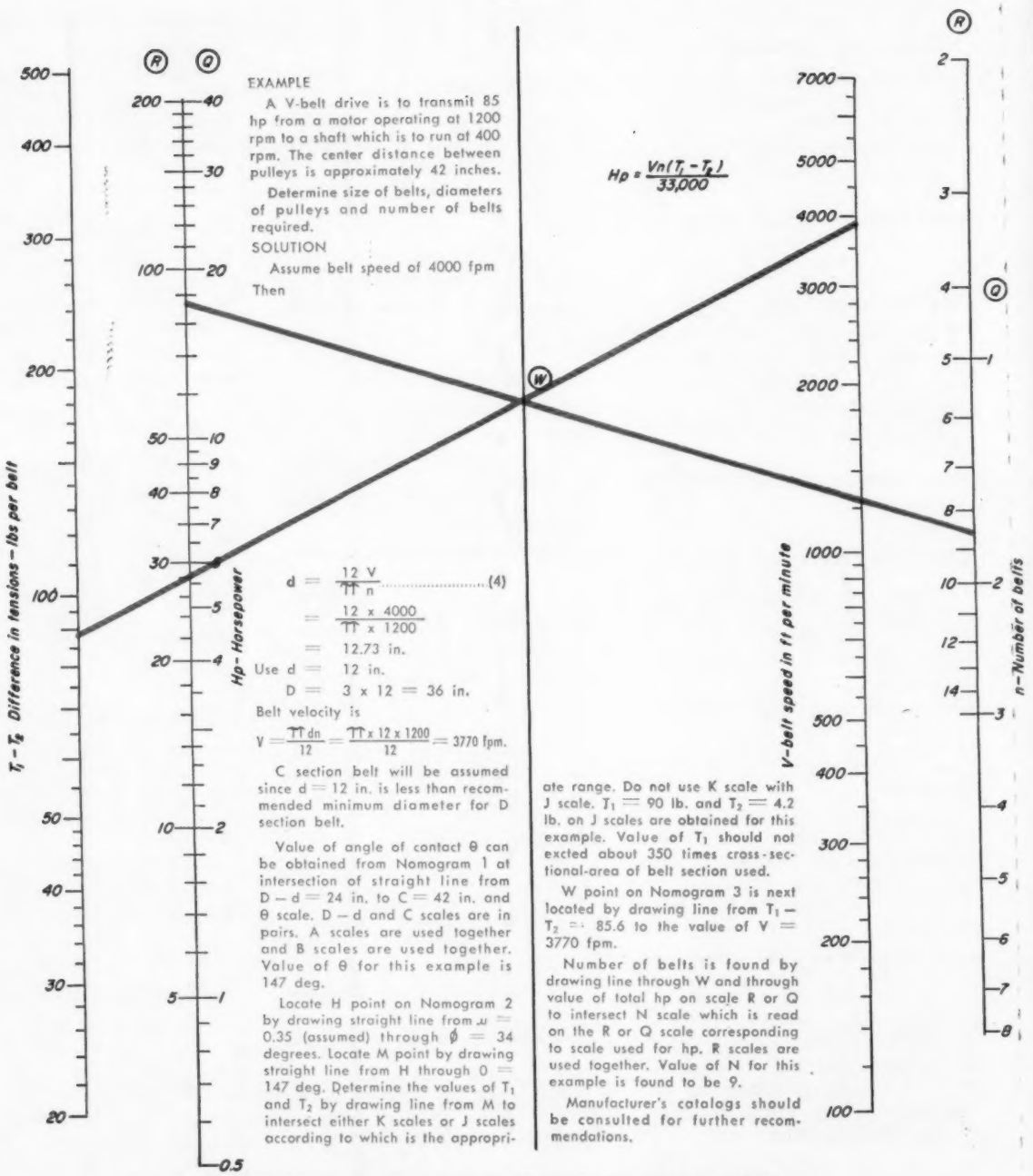
Bin-Dicator Co., Detroit, Mich.

Circle number 4 on reader service card

Continued on page 58

Nomograms for complete multiple

V-BELT DRIVE 3



EXAMPLE

A V-belt drive is to transmit 85 hp from a motor operating at 1200 rpm to a shaft which is to run at 400 rpm. The center distance between pulleys is approximately 42 inches.

Determine size of belts, diameters of pulleys and number of belts required.

SOLUTION

Assume belt speed of 4000 fpm

Then

$$d = \frac{12\ V}{\pi\ n} \quad \ldots\ldots (4)$$

$$= \frac{12 \times 4000}{\pi \times 1200}$$

$$= 12.73 \text{ in.}$$

Use d = 12 in.

D = 3 x 12 = 36 in.

Belt velocity is

$$V = \frac{\pi\ dn}{12} = \frac{\pi \times 12 \times 1200}{12} = 3770 \text{ fpm.}$$

C section belt will be assumed since d = 12 in. is less than recommended minimum diameter for D section belt.

Value of angle of contact θ can be obtained from Nomogram 1 at intersection of straight line from D – d = 24 in. to C = 42 in. and θ scale. D – d and C scales are in pairs. A scales are used together and B scales are used together. Value of θ for this example is 147 deg.

Locate H point on Nomogram 2 by drawing straight line from μ = 0.35 (assumed) through ϕ = 34 degrees. Locate M point by drawing straight line from H through θ = 147 deg. Determine the values of T_1 and T_2 by drawing line from M to intersect either K scales or J scales according to which is the appropriate range. Do not use K scale with J scale. T_1 = 90 lb. and T_2 = 4.2 lb. on J scales are obtained for this example. Value of T_1 should not excted about 350 times cross-sectional-area of belt section used.

W point on Nomogram 3 is next located by drawing line from $T_1 - T_2$ = 85.6 to the value of V = 3770 fpm.

Number of belts is found by drawing line through W and through value of total hp on scale R or Q to intersect N scale which is read on the R or Q scale corresponding to scale used for hp. R scales are used together. Value of N for this example is found to be 9.

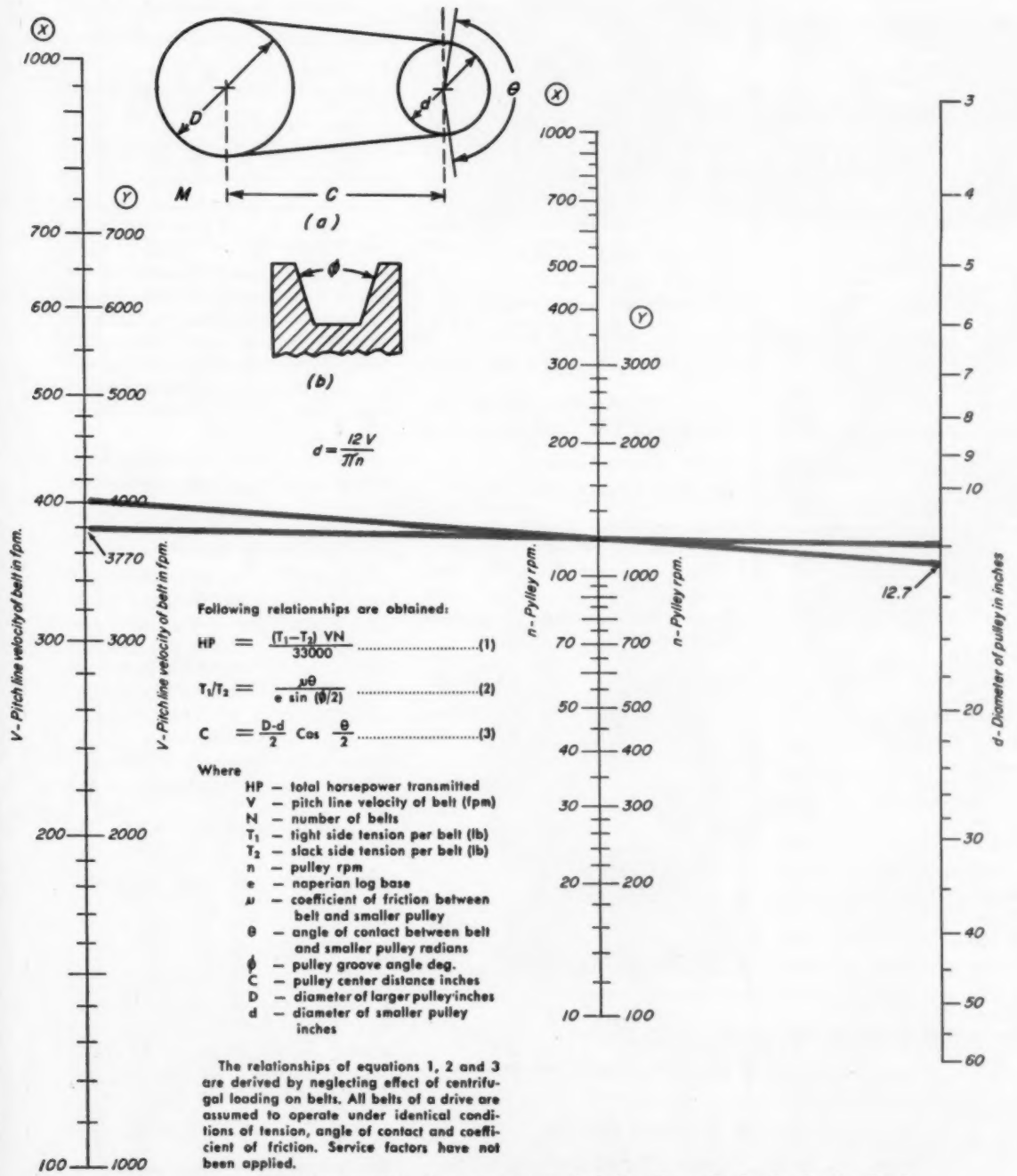
Manufacturer's catalogs should be consulted for further recommendations.

For a free reprint of four nomograms circle No. 250 on the Reader Service Card

By J. N. ARNOLD, *professor, qnd*
ALLAN C. DUNK, *assistant professor, Purdue University*

V-belt drive installation PART 2

These two nomograms complete series of four



Following relationships are obtained:

$$HP = \frac{(T_1 - T_2)\,VN}{33000} \quad \text{.....(1)}$$

$$T_1/T_2 = \frac{\mu\theta}{e \sin(\phi/2)} \quad \text{.....(2)}$$

$$C = \frac{D-d}{2} \cos\frac{\theta}{2} \quad \text{.....(3)}$$

Where

- HP — total horsepower transmitted
- V — pitch line velocity of belt (fpm)
- N — number of belts
- T_1 — tight side tension per belt (lb)
- T_2 — slack side tension per belt (lb)
- n — pulley rpm
- e — naperian log base
- μ — coefficient of friction between belt and smaller pulley
- θ — angle of contact between belt and smaller pulley radians
- ϕ — pulley groove angle deg.
- C — pulley center distance inches
- D — diameter of larger pulley inches
- d — diameter of smaller pulley inches

The relationships of equations 1, 2 and 3 are derived by neglecting effect of centrifugal loading on belts. All belts of a drive are assumed to operate under identical conditions of tension, angle of contact and coefficient of friction. Service factors have not been applied.

For a free reprint of four nomograms circle No. 250 on the Reader Service Card

CONTINUED *from page 55*

Universal joints

Illustrated catalog gives dimensions and suggestions for use of Atlas joints. 15 sizes for all requirements.

Gray & Prior Machine Co., Hartford, Conn.

Circle number 16 on reader service card

Fluid couplings

Data on recommended hydro-sheave drive sizes for alternating-current electric motor drives.

Twin Disc Clutch Co., Hydraulic Div., Rockford, Ill.

Circle number 26 on reader service card

Overrunning clutch

Utmost torque capacity in minimum of space for power transmission on overrunning, backstopping and indexing applications

Formsprag Co., Warren, Mich.

Circle number 32 on reader service card

Bronze bearings

Bronze sleeve bearings and bushings, wide range assemblies and finishes. Complete Randall line now available.

Machine Parts Co., Berwyn, Ill.

Circle number 19 on reader service card

Timing belt

PowerGrip timing belt drive gives positive drive with no slippage. Fine for automatic split-second action on production machines, other installations. Speeds to 16,000 fpm.

U. S. Rubber Co., New York, N. Y.

Circle number 28 on reader service card

Motoreducers

All-steel construction helical-geared reducers with 12 to 15 percent reserve load-carrying capacity. To 75 hp, output speeds from 1.2 to 780 rpm. Horizontal, vertical or right-angle.

Falk Corp., Milwaukee, Wisc.

Circle number 12 on reader service card

Chain couplings

Roller chain flexible couplings correct angular misalignment, are furnished complete for installation. Bore sizes from 7/16 to 4⅝ in.

Cullman Wheel Co., Chicago, Ill.

Circle number 8 on reader service card

Speed reduction drive

Shaft-King tapered-hub unit for wide range of speeds by sheave or V-belt substitution. 5:1, 13:1 and 20:1 are standard ratios from stock.

American Pulley Co., Philadelphia, Pa.

Circle number 34 on reader service card

Custom-cut gears

Precision-cut to exact tolerances. Spur, bevel, helical, spiral, internal, rack, etc., wide range of pitches. Bulletin gives details.

Abart Gear & Machine Co., Chicago, Ill.

Circle number 1 on reader service card

AC motors

Dependable motors, 1 to 600 hp in all popular models. Brochure shows full line.

Brook Motor Corp., Chicago, Ill.

Circle number 5 on reader service card

Universal joints

Single and double joints, 14 sizes from ⅜ to 4 in. OD always in stock.

Curtis Universal Joint Co., Inc., Springfield, Mass.

Circle number 9 on reader service card

Clutch line

Bulletin shows typical installations and furnishes capacity tables, dimensions, specifications.

Rockford Clutch Div., Borg-Warner Corp., Rockford, Ill.

Circle number 23 on reader service card

Bronze bearings

2227 sizes cast, sintered oil-filled stock bearings. Engineering handbook and catalog 58 give full specifications.

Bunting Brass and Bronze Co., Toledo, Ohio.

Circle number 6 on reader service card

High-speed indexing

Catalog 108, 24 pages, illustrated, gives data on high speed, precision, roller gear drive indexing mechanisms for intermittent and oscillating motions. Units rated for speeds up to 2,000 indexes per minute. Stock and standard components and housed units are shown, as well as Trans-Pac power assemblies, right angle drives and gear reducers. Information for calculating load requirements and designing an installation is provided.

Ferguson Machine Corp. of Indiana, St. Louis, Mo.

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Case histories

Company's house publication, Fluid Power News, number 9 illustrates and describes how application engineers solved linear and rotary drive problems. Four interesting situations are covered, involving many common design elements. Four pages, well illustrated.

The Oilgear Co., Milwaukee, Wisc.

Circle number 41 on reader service card

D-C packaged drives

Ultraflex E is an adjustable speed drive in sizes from 1 to 40 hp which uses electronic tubes for power conversion from a-c source. Light and compact power conversion units save 50 percent or more in floor space and up to 75 percent in weight of what is normally required with the conventional motor generator set. Booklet EN-64 gives full information on the line.

Cutler-Hammer Inc., Milwaukee, Wisc.

Circle number 43 on reader service card

In-line gearmotors

Two types of gearmotors and motor reducers with integral NEMA type motors are described in illustrated catalog 47-ME, 18 pages. All information necessary for selection and ordering is included in clear form.

D. O. James Gear Mfg. Co., Chicago, Ill.

Circle number 49 on reader service card

New unitized motors

Twelve-page illustrated bulletin GEA-6882 with inserted 4-page technical data bulletin discusses design features and advantages of new unitized motor line. Thorough emphasis on efficiency, bearings, versatility of application, and insulation system. Technical bulletin gives construction features, performance data, mechanical variations and dimensions of four-pole, 59-frame, shaded-pole and permanent-split capacitor motors, 0.001 to 1/15 hp.

General Electric Co., Schenectady, N. Y.

Circle number 42 on reader service card

Right angle gearmotors

Gearmotors and motor reducers for vertical and horizontal drives are shown in Catalog 46-F, 25 pages, illustrated. Ratio range from 5.66:1 to 100:1, hp range from ⅓ to 30. Catalog construction specifications, information on selection, mounting, service classifications and detailed ratings. Typical installations are also treated pictorially.

D. O. James Gear Mfg. Co., Chicago, Ill.

Circle number 48 on reader service card

Standard broaches

Sixteen-page catalog lists 34 additions to company's line of Minute Man standard stock broaches. Included are nine sizes of square and hexagonal broaches, three sizes of production-type keyway broaches and a complete new line of stock round broaches.

The du Mont Corp., Greenfield, Mass.

Circle number 47 on reader service card

Flexible couplings

Catalog C-58 shows six types of flexible couplings in bore size ranges from solid to 9½ in., hp ranges from 1/20 to 4254. Three styles have one-piece spider cushions, three have individual load cushions, with many variations of mounting and material possible. Handy hp-torque conversion tables and engineering data are included. 20 pages, illustrated.

Lovejoy Flexible Coupling Co., Chicago, Ill.

Circle number 44 on reader service card

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ABSTRACTS *of current technical papers*

Design and application of belts,

BY E. S. CHEANEY, C. L. PAULLUS AND W. C. RARIDAN
Principal Engineers, Battelle Memorial Institute

NEW MATERIALS, improved manufacturing techniques, and advanced ideas have produced real advances in belt, chain and gear power transmission systems, recently. This article will review present status of these three basic ways for transmitting power between rotating shafts. Also, a method for choosing among these, based on a comparison of requirements and characteristics, is included.

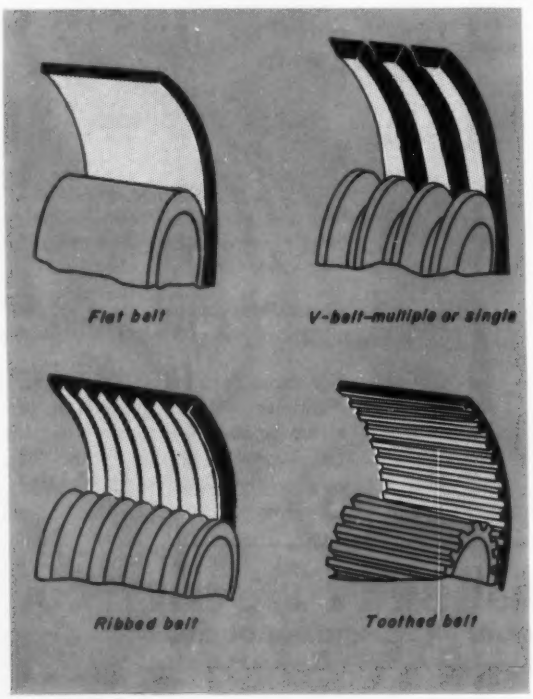

Fig. 1. Belt types.

Transmission Types

Belts: Four types of belt drives, Fig. 1, handle the bulk of the power transmitted through belting. Load-carrying ability and life of V- and flat belts have been improved by using better materials. Power range is also being extended.

Addition of a plastic inner ply to flat belting has resulted in marked improvement. Ribbed belts are a combine strength and simplicity of flat belting with high grip and positive groove tracking of V-belting. Toothed belts have positive drive and high speed ratings.

Chain: Many types of chain have been developed to fill a wide range of requirements, Fig. 2. Improvements in materials, heat treating, and better tolerances have produced longer-lasting, higher-strength chain. Available in a variety of materials, chain may be had with high temperature and corrosion resistance, and for other special environmental conditions.

Bead chain, Fig. 2e, is useful for low speeds and powers. It may be used with shafts skewed as much as 90 deg. Bead chain may also be used on intersecting shafts with included angles up to 40 deg.

Inverted tooth silent chain, Fig. 2d, has a rocker joint at the point of articulation. This eliminates chordal action so that uniform motion is imparted to the driven sprocket.

A unique variable silent-chain drive has been developed, Fig. 2f. Tooth-forming chain operates between grooved conical wheels. Sheave halves can be moved in and out to change the speed ratio as the chain is forced to ride on a greater or smaller pitch diameter.

Gears: Gears may be lumped into three broad categories; (1) parallel-shaft gears, (2) intersecting shaft gears, and (3) skewed shaft gears, Fig. 3. Although the gear pairs in Fig. 3b and Fig. 3c are shown with shafts normal to each other, any included angle can

This article was abstracted from a paper presented at the Design Engineering Conference, Philadelphia, Pa., May 25-28, 1959.

chain, and gears

be accommodated with these gear types.

The tapered worm gear is a recent addition to the skewed-axis family of gears. Its tapered pinion lets it engage the teeth on a bevel gear. This arrangement fills the gap between shaft arrangements for hypoid and worm gears. These gears can be made on standard generating tools, have multiple tooth contact, and wide ratio range.

Design Procedure

There are three steps to follow to determine which of these drive methods to use and the final specific type. These are:

1. Determine transmission requirements.
2. Make preliminary type selection.
3. Make detailed selection of optimum drive.

Determining requirements: Usually, hp, speed ratio, and rpm of at least one shaft and required life are known. Other special requirements such as extreme quietness, speed adjustment, etc. must also be uncovered.

Preliminary selection: Table lets a quick comparison of drive requirements and properties be made. The table is based on 12 factors such as speed, load, etc. These have been divided into two groups—general factors and special factors. General factors are those present in any power transmission situation. Special factors are related to particular situations.

Final selection: A detailed study of the most promising systems selected in the preliminary stage will uncover the final drive. This process takes most of the engineering time, but is simple and basically the same regardless of the mechanisms being considered. Known requirements must here be supplemented by as many assumptions as necessary to completely specify all design parameters.

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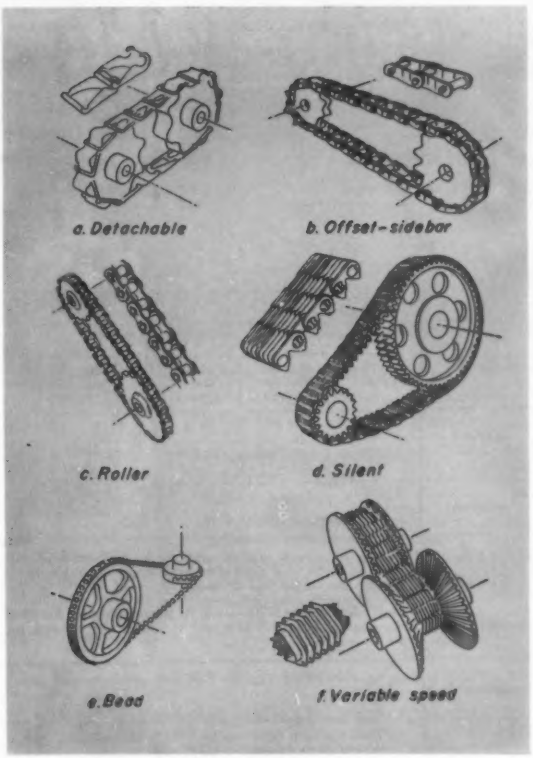
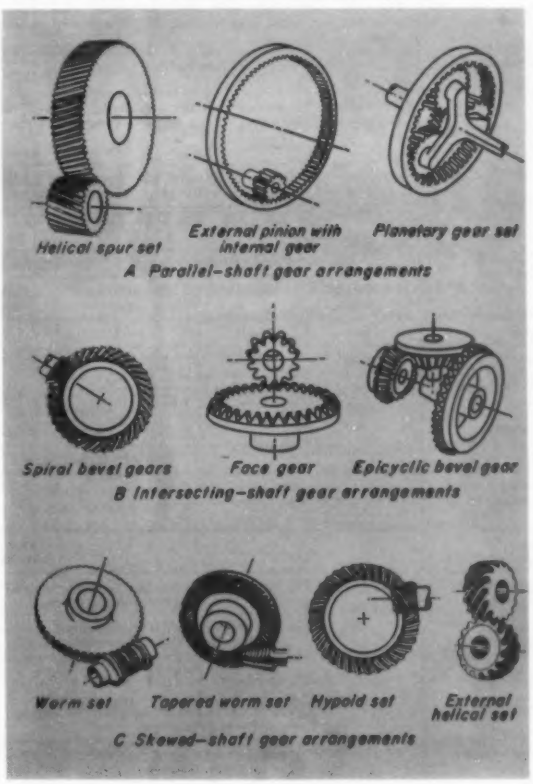


Fig. 2. Common chain types.

Fig. 3. Gears classified by shaft arrangement.



BELTS, CHAIN and GEARS *continued from preceding page*

Data for calculations comes from many sources. Belt and chain data from any manufacturer's catalog will quickly give available sizes of sprockets and pulleys and the corresponding load-carrying capacities From this, detailed calculations can be made. Designing for a specific life with chain and belts is not considered in most chain and belt manufacturer's catalogs and requires an empirical approach.

For gears, the complex selection problem can be simplified by using the standard rating method of the AGMA. This is conveniently arranged and deals with such things as materials, tooth geometry and stress analysis.

When complete, detailed design specifications have been prepared, final selection is made on the basis of cost. This can be done only when all components such as bearings, lubrication cases, idlers, automatic tensioning devices, and machined housings are considered. ▲▲▲

PROPERTIES AND CAPABILITIES OF BELTS, CHAINS, AND GEARS

TABLE 1

		BELTS						CHAINS					
		Leather (Flat)	Rubber Fabric (Flat)	Plastic Core (Flat)	Standard (Vee)	Steel Cable (Vee)	Toothed	Bead	Detachable	Pintle	Offset-Side-Bar	Inverted Tooth (Silent)	Roller
GENERAL DESIGN FACTORS	Ratio	16:1	16:1	20:1	12:1	12:1	11:1	—	2-1/2:1	2-1/2:1	4:1	12:1	8:1
	Speed (fpm)	6000	13,000	24,000	5000	8000	15,000	200	350	450	1000	6500	5000
	Load (Equivalent width)	5.9	—	—	6.7	—	3.0	—	—	—	—	1.9	1.6
	Life	Depends on speed, pulley diameters, tension and total belt length. Published data and selection procedure available for vee belts. Generally less than 15,000 hours.						Catalogue selections based on 15,000 hours.					
	Center Distance	Independently variable — no interrelationship between pulley diameters and distance. Wear and retensioning takeup adjustment must be provided.						Independently variable — no interrelationship between sprocket diameters and center distance. Wear takeup required.					
SPECIAL DESIGN FACTORS	Shaft Relationship	Can be skewed up to 180° but belt capacity and life will be reduced accordingly.						Can be skewed to 90°	Shafts must be nominally parallel.				
	Ratio Accuracy	Subject to slip and creep. Normal amounts are 1 to 5% but amounts vary widely with tension ratio and contact pressure.					Fixed ratio	Fixed ratio. Instantaneous velocity ratios vary cyclically with chordal action					
	Vibration, Noise	Generally free of vibration. Subject to noise due to belt slap.		Quiet and free of vibration.			Vibration generated by teeth	Noise and vibration due to chordal action. Large diameter sprockets, flywheels, and special silent chain designs can minimize					
	Efficiency	Up to 98% at rated steady load. Efficiency will reduce with varying load.						96 — 99%					
	Lubrication	No lubrication required.						Will operate dry short-life or low load. Best life with splash or drip lubrication.					
	Environment	Practically any environmental condition can be met by proper selection of material. Temperature range —60 to +225° F.						Reduced life in abrasive atmosphere.	Cannot operate open in abrasive atmosphere. Special materials for corrosive atmospheres. Temperature range: —60 to 600° F				
	Maintenance	Retensioning	Retensioning	Special conditioner	Retensioning	Retensioning	—	Lubrication, retensioning and wear takeup.					

		GEARS									
		Parallel Shaft			Intersecting Shaft			Skew Shaft			
		Straight Spur	Helical	High-Speed Herringbone	Straight Bevel	Spiral Bevel	Face Gear	Worm	Tapered Worm	Hypoid	Crossed Helical
GENERAL DESIGN FACTORS	Ratio	6:1	10:1	15:1	4:1	4:1	10:1	75:1	200:1	6:1	—
	Speed (fpm)	4000	10,000	30,000	4000	8000	—	6000	6000	8000	6000
	Load (Equivalent width)	1.0	—	—	—	—	—	—	—	—	—
	Life	Consult latest AGMA publications. Can be greater than 15,000 hours.									
	Center Distance	$CD = \frac{D+d}{2} = \frac{d(R+1)}{2}$			No center distance since shafts intersect.			Center distance is not directly related to ratio or pitch diameter.			
SPECIAL DESIGN FACTORS	Shaft Relationship	———			Any included angle can be used.		90° normally	90° skew angle			Any angle
	Ratio Accuracy	All gearing delivers exact ratio. Instantaneous velocity is theoretically uniform — any variation is due to profile and spacing inaccuracies.									
	Vibration, Noise	Frequency generation is inherent due to tooth contact. Practically noiseless drives can be achieved by special design and fabrication measures.									
	Efficiency	98 — 99%			95 — 98%		—	20 — 98%		95 — 98%	Wide variation
	Lubrication	Lubrication required to achieve high efficiency. Plastic and impregnated materials are available for low-load dry applications.									
	Environment	Cannot operate open in abrasive atmospheres. Fully enclosed gears fairly independent of atmosphere. Ambient temperature range —60° to +300° F									
	Maintenance	Lubrication									

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Flexible shafts

Bulletin 250 covers four stock lengths, seven sizes and two coupling bearing types (bronze and ball) of flexible shafts. Core diameters are ¼, ⅜, ½, ⅝, ¾, 1, 1¼ in. Transmitted hp range for stock shafts is 1/20 to 10, with torques from .3 to 2100 lb-in. at operating speeds from 50 to 10,000 rpm. Booklet is 12 pages and is effectively diagrammed and illustrated.

B. W. Elliott Mfg. Co., Inc., Binghamton, N. Y.

Circle number 45 on reader service card

Intermittent drive unit

Completely packaged unit gives precise intermittent motion from constant source of rotary power. Compact size aids in versatility of installation. Combinations of motions under precise control are well presented in four-page bulletin IDU, with full specifications given.

Hilliard Corp., Elmira, N. Y.

Circle number 46 on reader service card

Versatile couplings

Sure-Flex couplings have special four-way flexing action that absorbs all types and combinations of angular and parallel misalignment and end-float. No metal to metal contact, easy to install.

T. B. Wood's Sons Co., Chambersburg, Pa.

Circle number 31 on reader service card

Universal joints

Rzeppa line gives smooth torque even at angles up to 35 deg. Wide variety of sizes, angles, speed and styles, for front drives, articulating axles, propeller shafts and special applications.

Con-Vel Div., Dana Corp., Detroit, Mich.

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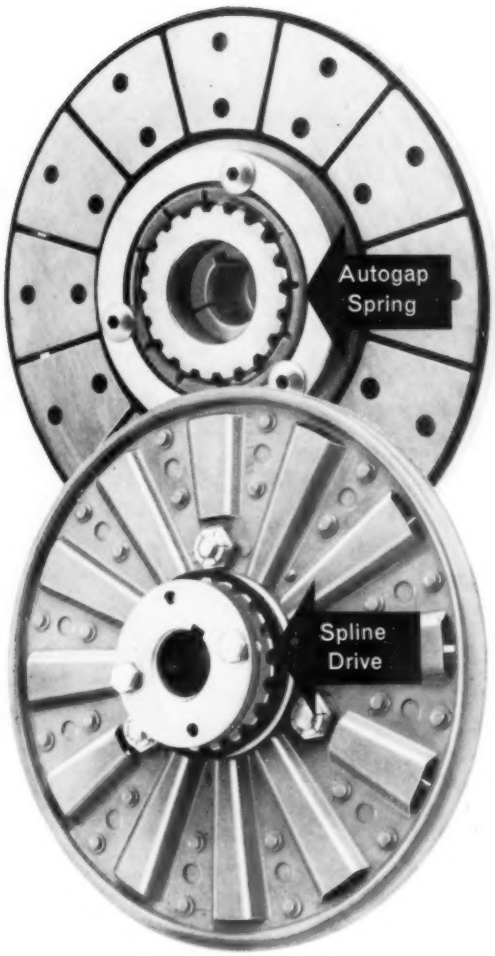
NEW SPLINE-DRIVE ARMATURE



for Warner electric brakes and clutches ... reduces maintenance and assembly costs

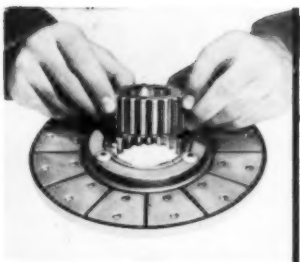
Now, you can reduce maintenance downtime, speed assembly, prolong armature life, and make heavy-duty, high-cycle machinery more automatic—more productive.

Warner's new armature drive provides greater bearing area, distributes heavy shock loads evenly over multiple involute splines, virtually eliminates wear, and increases armature life.

Easy assembly and fast alignment reduce installation cost. (See illustrations below.) Sliding fit between mating hub and adapter lets armature creep axially, compensating automatically for wear. Patented one-piece autogap spring maintains a constant air gap when magnet is de-energized—assures efficient, snap-action release.

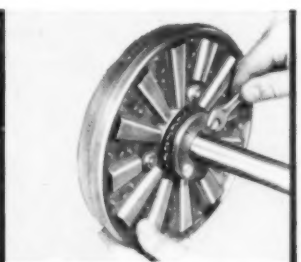
Spline drive armatures are available from stock for use with Models 825, 1000, 1225, and 1525 Warner electric brakes and clutches.

To learn more about these rugged, low-cost drives for high-cycle applications, write for Bulletin P-68.

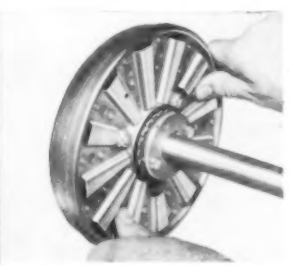


1 Unique design speeds mounting and alignment, cuts assembly costs. Spline drive distributes load, reduces wear, increases armature life.

2 With splined hub in place, tapered bushing is inserted in armature assembly and bushing holes aligned with tapped holes in splined hub.



3 Complete armature is mounted on shaft and placed in contact with magnet face. Tightening capscrews locks armature assembly to shaft.

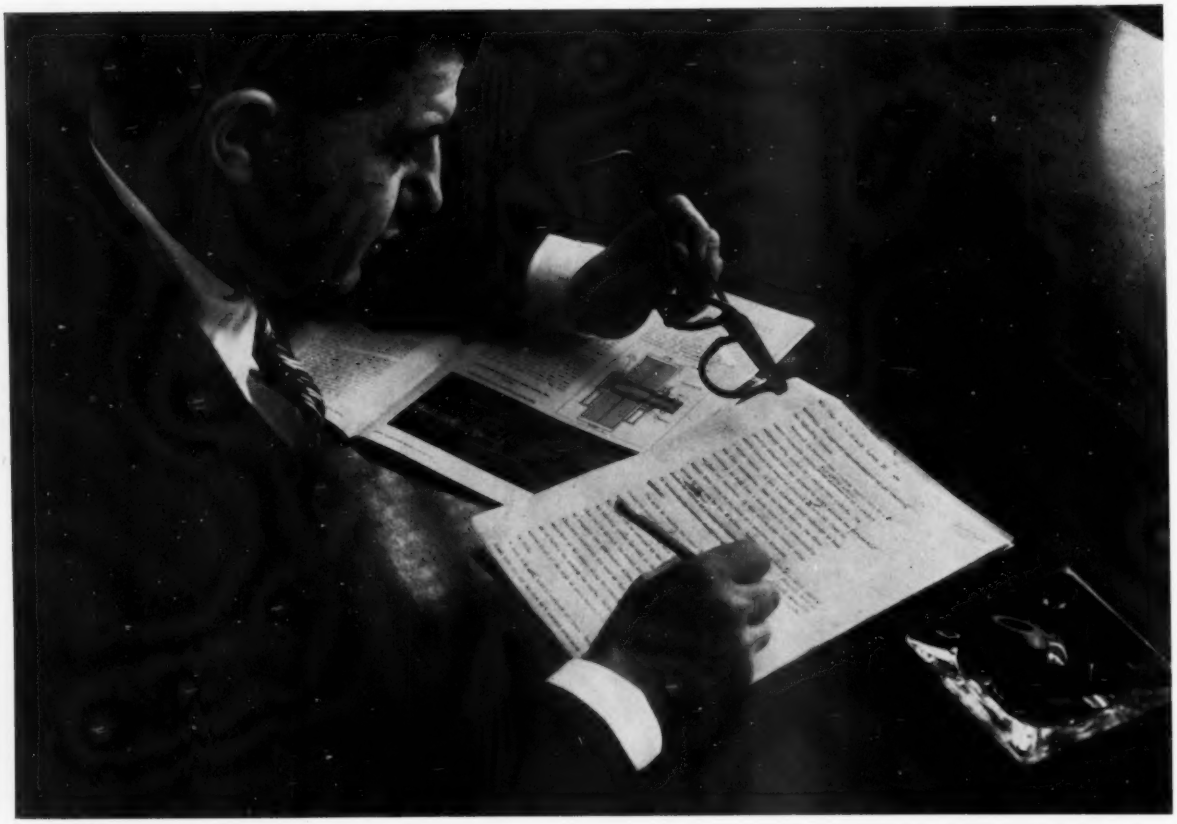


4 One-piece autogap spring automatically aligns assembly when armature is pushed against magnet and released.

WARNER

Warner Electric Brake & Clutch Company
Beloit, Wisconsin

For More Information Circle No. 30 on the Reader Service Card.



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